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ACUTE PERFORATED GASTRODUODENAL ULCER

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THIS is the report of 129 patients with acute perforated gastroduodenal ulcers admitted to the Surgical Service of the John Gaston Hospital between Jan. 1, 1940, and Jan. 1, 1947. All patients were operated upon. During this 7 year period no patient with acute perforated ulcer was treated without operation. Perforated gastrojejunal ulcers and chronic perforated gastroduodenal ulcers are not included in this survey.

Thirteen deaths due to acute perforation occurred in this series, giving a general mortality rate of 10.01 per cent.

The Resident Staff operated upon 114 patients, and the Attending Staff operated upon the remaining 15 patients. Statistically, no difference in results was obtained by the two Staffs.

The John Gaston Hospital admits only the indigent of Memphis and Shelby County. The majority of the indigent in this locality belong to the colored race. The John Gaston Hospital, therefore, affords an unusual opportunity for study of disease in the negro.

Incidence.—During the 7 years covered by this report 117,600 patients were admitted to the Hospital. Peptic ulcer was diagnosed

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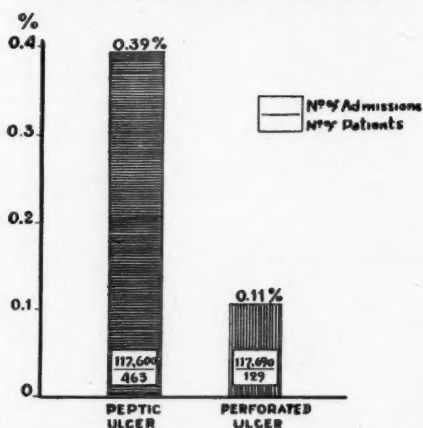
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in 463 patients and acute perforation in 129. The hospital incidence of peptic ulcer was 0.39 per cent and that of acute perforation 0.11 per cent. Acute perforation occurred in 27.9 per cent of the peptic ulcers (Graph I). The hospital incidence in the collected series of DeBakey^{2,3} was 0.66 per cent for peptic ulcer and 0.09 per cent for acute perforation. The lower incidence of peptic ulcer in the John Gaston Hospital may be explained partially by the low economic level of the patients. Explanation of the higher per cent of perforation is difficult. Perhaps patients served by the John Gaston Hospital tolerate the relatively mild pain of uncomplicated peptic ulcer better than patients from a higher economic level.

JOHN GASTON HOSPITAL INCIDENCE OF
PEPTIC ULCER AND RUPTURED
GASTRO-DUODENAL ULCER.



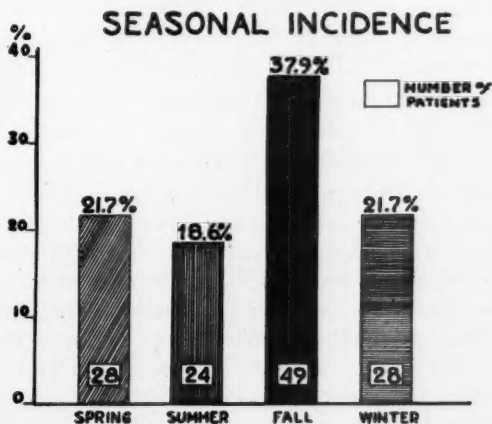
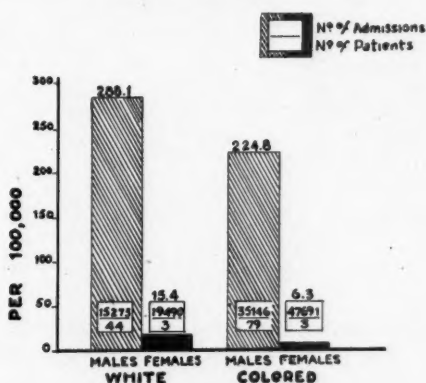
Race and Sex Incidence.—Perforated ulcers occurred in 79 colored men, in 44 white men, in 3 colored women, and in 3 white women. When the race and sex incidence is calculated on the basis of 100,000 hospital admissions in each category, the actual incidence may be appreciated (Graph II). In this series acute perforations occurred at the rate of 224.8 colored males per 100,000 admissions and 288.1 white males per 100,000 admissions. This ratio is almost identical with 749 perforations in negroes to 982 in whites, as reported by Garner.⁵ He made no sex differential.

The incidence in females shows quite a different ratio. At the John Gaston Hospital approximately 2 colored women would have perforated ulcers to 5 white women if in the total admissions they

were numerically equal. The colored woman is least likely to have a perforated ulcer.

Seasonal Incidence.—It is difficult to rationalize a seasonal variation in perforated ulcer and DeBakey^{2,3} has shown no significant seasonal variation in 2,334 collected cases. In the John Gaston

INCIDENCE OF PERFORATED ULCER PER 100,000 ADMISSIONS ACCORDING TO SEX AND RACE



Hospital, however, acute perforations were significantly the same in the spring, summer, and winter, averaging 20.7 per cent per season. In marked contrast, the incidence rose to 37.9 per cent in the fall (Graph III). Odom & DeBakey⁸ also report an increased incidence in the fall.

Diagnosis.—The symptoms and physical signs of acute perforated ulcer are so classical that no attempt has been made to analyze them in this report. An accurate preoperative diagnosis was made in 111 (86 per cent) of the 129 patients. Appendicitis, ruptured or unruptured, was the diagnosis in 15, or 11.6 per cent.

TABLE 1
POSTOPERATIVE COMPLICATIONS OCCURRING IN 129 PATIENTS

Type	Number of Patients	Percentage
Wound Infection (Including disruption)	35	27.1
Pulmonary (Atelectasis and pneumonia)	20	15.5
Peritonitis (Generalized and abscess)	21	16.2
Duodenal Fistula	1	0.9

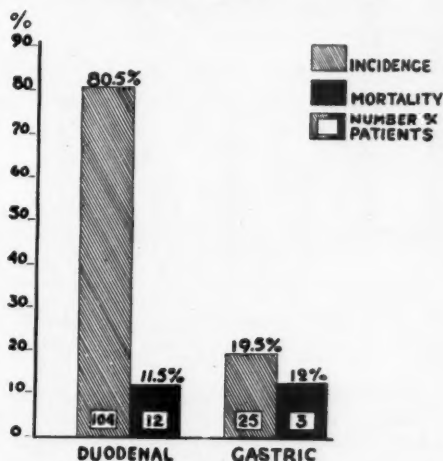
Roentgenologic examination for pneumoperitoneum was made on 86 patients with positive findings in 46, or 55.4 per cent. In DeBakey's collected series pneumoperitoneum occurred in 69.4 per cent. The incidence of positive roentgenologic evidence of pneumoperitoneum could be increased remarkably by introducing air into the stomach through a Levine tube prior to examination, but a deliberate increase in intragastric pressure does not seem desirable to us.

Operation.—We believe, with Graham,⁷ that a surgeon's primary duty to a patient with perforated ulcer is to save that patient's life. Following that concept, perforated ulcers at the John Gaston Hospital are closed in the simplest way possible. In this series simple closure by the Graham⁷ or Gatch and Owen⁶ technic was done in 117 patients. Closure plus gastrojejunostomy was done in 2 and subtotal gastrectomy was done in 3. The operative procedure was described incompletely in 7 cases. The mortality of simple closure was 9.7 per cent. There were too few of the other types of operation to permit calculation of significant mortality rates.

General anesthesia was given to practically all of these patients. DeBakey,^{2,3,4} Baritell,¹ Thompson,¹⁰ and Graham⁷ have shown such a decidedly lower mortality rate when spinal anesthesia is used that the adoption of spinal anesthesia offers an opportunity to lower the mortality rate in future cases.

Postoperative Complications.—Table 1 shows the postoperative complications. The high incidence of wound infections and peritonitis may be explained, probably, by the high incidence of patients who arrive at the operating table more than 6 hours after perforation (Graph VII).

INCIDENCE AND MORTALITY OF
PERFORATED ULCER ACCORDING TO
LOCATION IN 129 PATIENTS



General Mortality Rate.—In this series of 129 patients there were 15 deaths, giving an uncorrected mortality rate of 11.6 per cent (Table 2). Two of these patients recovered from their perforations but died of pre-existing diseases. One of these had far advanced pulmonary tuberculosis and died on the 72nd postoperative day. Postmortem examination showed the ulcer closure to have been adequate and there was no evidence of any complication of the perforation. The other patient had hypertensive cardiovascular disease with auricular fibrillation and myocardial failure on admission. The decompensation did not respond to treatment, and the patient died on the 49th postoperative day with no clinical evidence of intraabdominal disease attributable to the perforated ulcer.

If these 2 deaths may be subtracted from the 15, the corrected mortality rate for this series is 10.1 per cent.

Postmortem examination was performed on 9 of the 15 patients who died. This examination showed that the closure of every ulcer

had been adequate. In one patient an anterior gastric ulcer was closed at operation and postmortem examination showed that a

TABLE 2
GENERAL MORTALITY

<i>Number of Patients</i>	<i>Number of Deaths</i>	<i>Mortality</i>
129	15 (Uncorrected)	11.6%
129	13 (Corrected)	10.1%

posterior ulcer had been overlooked. The primary cause of death was generalized peritonitis, an undrained abscess, or both, in all patients examined postmortem.

TABLE 3
MORTALITY ACCORDING TO TOTAL LEUKOCYTE COUNT IN 112 PATIENTS
WITH PERFORATED ULCER

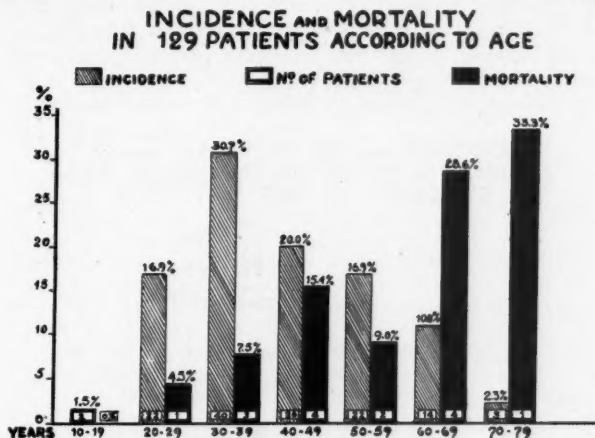
<i>Leukocyte Count</i>	<i>Number of Patients</i>	<i>Deaths</i>	<i>Mortality</i>
3,000-6,000	6	4	66.6%
6,000-12,000	31	1	3.2%
12,000-18,000	51	3	5.9%
Above 18,000	24	1	4.2%

Leukocyte Count.—The preoperative leukocyte count has distinct prognostic value as shown in Table 3. Six patients had preoperative leukocyte counts between 3,000 and 5,500. Four of these 6 died, giving a mortality rate of 66.6 per cent. All of the 6 patients were "late" ones. One was operated upon 7 hours after perforation and the other 5 more than 20 hours after perforation.

A low leukocyte count in patients with acute pyogenic infections is generally recognized as indicating a lowered resistance of the patient. Apparently this is true in acute perforated ulcer.

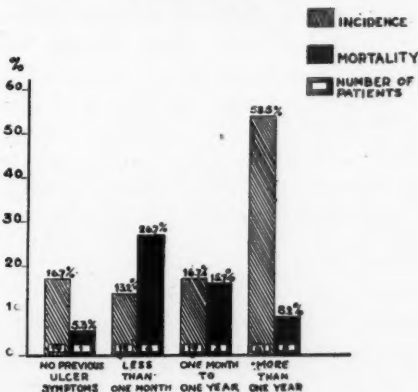
Location of Ulcer.—Perforated duodenal ulcer was described in 80.5 per cent of the patients and gastric ulcer in 19.5 per cent (Graph IV). The mortality of each was the same. In patients with perforated peptic ulcer the pylorus frequently is extremely difficult to identify. For this reason, the reported incidence of perforated gastric and duodenal ulcerations is likely to be inaccurate.

Age.—Graph V plots the incidence and mortality by decade. This graph emphasizes the higher incidence of perforation in the young and middle ages and the increasing mortality rate with in-



creasing years. The peak incidence occurs in the fourth decade and the peak mortality in the eighth decade. This corresponds with the collected cases of DeBakey^{2,3} and also with the concept that peptic

**INCIDENCE AND MORTALITY OF PERFORATED
ULCER ACCORDING TO DURATION OF ULCER
SYMPTOMS PRIOR TO PERFORATION IN
114 PATIENTS**

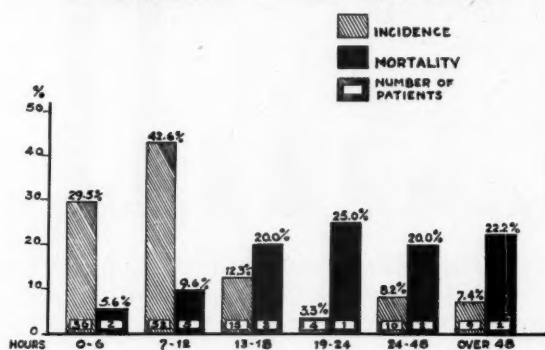


ulcer, in general, has its greatest incidence in the third, fourth, and fifth decades.

Ulcer Symptoms Prior to Perforation.—Perforation was the first

ulcer symptom in 19 (16.7 per cent) of the patients. The mortality of this group was 5.3 per cent. Thirty-four patients had ulcer symptoms of less than one year's duration with a mortality of 20.6 per cent. The remaining patients (61) had had ulcer symptoms from 1 to 30 years with a mortality rate of 8.2 per cent (Graph VI). The explanation of the low mortality rate in the patients with old ulcers must await further investigation.

**INCIDENCE AND MORTALITY ACCORDING TO
NUMBER OF POST-PERFORATIVE HOURS PRIOR
TO SURGERY IN 122 PATIENTS.**



Post-Perforative Hours.—It is generally assumed that the mortality rate of acute perforated ulcer is directly proportional to the number of hours intervening between the perforation and its surgical closure. In this series that is true (Graph VII). That the patients at the John Gaston Hospital are operated upon later than the average elsewhere is demonstrated by a comparison with the collected cases of DeBakey.^{2,3} He collected 7,683 cases from the literature and 2,999, or 38.9 per cent, were operated upon in the first 6 hours. The John Gaston Hospital series, with 29.5 per cent, falls well below the general average.

SUMMARY

1. A critical review of 129 patients with acute perforated gastroduodenal ulcer is presented. The corrected mortality rate is 10.1 per cent.
2. A sex and race differential in the incidence per 100,000 admissions is made, showing that if the races and sexes were numerically equal, 7 colored men would have acute perforated ulcers to 9 white men and 2 colored women to 5 white women.

3. A preoperative leukocyte count below 6,000 gives a poor prognosis.

4. The mortality rate is lower in those patients having no previous symptoms and in those with symptoms which have been present for more than one year prior to perforation.

5. The mortality rate of acute perforated gastroduodenal ulcer is directly proportional to the number of hours intervening between perforation and closure.

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INDICATIONS FOR CORNEAL TRANSPLANTATION

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CORNEAL transplantation is now an established procedure in Ophthalmology. It is possible in favorable cases to obtain a vision of 20/50 or better and occasionally even 20/20. Vision in unfavorable cases may be improved to a worthwhile degree. This presentation is based upon experimental work carried out at the University of Tennessee and 72 keratoplasties performed at the Memphis Eye, Ear, Nose & Throat and John Gaston Hospitals.

The great majority of cases presenting corneal opacity are not candidates for corneal transplantation either because the impairment of vision is not sufficient to warrant the risk of surgical intervention or because the damage to the cornea and eye as a whole is so great that keratoplasty would be useless.

Broadly speaking, corneal transplantation is indicated in any case wherein corneal opacity is the principal cause of disabling reduction of vision, wherein there is no active inflammation, light projection is good, and tension normal. The operation should be postponed until all signs of inflammation have subsided and cicatrization has been completed. The eyes should have been quiet for at least 6 months following disease (infection or specific lesion) and trauma and even longer in cases caused by the burns of chemicals, flame or molten metals.

Light projection as an indication of retinal and optic nerve function is valuable in the denser corneal opacities as in cataract.

Glaucoma invariably causes opacification of the graft. The intraocular pressure, therefore, must be normalized by appropriate operations before keratoplasty is performed. The operation is contraindicated in very dense opacities involving the entire cornea. The graft is unable to derive sufficient nutrition from scar to maintain itself as a transplant tissue. For this reason it must be possible to place the graft in contiguity with at least relatively normal cornea. Absence of anterior chamber and extensive anterior synechiæ make the prognosis extremely poor.

Cases for corneal transplantation may be divided into two general categories:

1. The favorable cases are those wherein the corneal opacity is

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either not very dense or the scar is central and may be excised almost completely, leaving the graft in contact with healthy corneal tissue; the anterior chamber is normal and there is no evidence of severe



Fig. 1. Corneal Ulcers. Densely vascularized and scarred cornea. This graft subsequently became quite opaque.



Fig. 2. Corneal Ulcers. Superficial opacity with peripheral vascularization only. The corneal stroma was healthy.

damage to the eye beyond the cornea. A high percentage of clear grafts may be expected in this type of case with vision ranging from 20/50 to 20/20. These favorable conditions may be found as a result of:

(a) Superficial ulcers or burns which have not affected the deep corneal stroma.



Fig. 3. Chemical Burn. Scarring dense below only. Graft in contact with healthy cornea above.



Fig. 4. Thermal Burn. Opacity mostly central and superficial. The corneal stroma healthy.

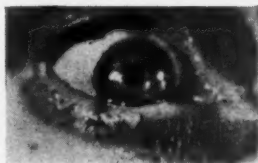


Fig. 5. Trachoma. Superficial scarring and pannus.

(b) Severe ulcers, deep keratitis or trauma affecting the central portion of the cornea but surrounded by relatively uninvolved corneal tissue.

(c) Interstitial keratitis wherein the residual opacity is not too dense and vascularization is light. The operation should not be performed under a year after the onset of the disease. Treatment

for the specific infection should have been completed or at least well advanced to prevent recurrence of the keratitis.

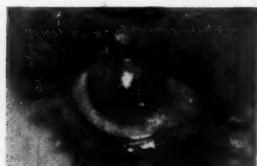


Fig. 6. Interstitial Keratitis. Cornea densely scarred throughout.

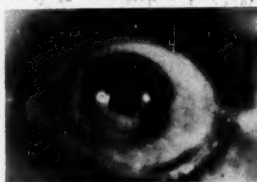


Fig. 7. Interstitial Keratitis. Cornea densely scarred below but relatively normal above.



Fig. 8. Interstitial Keratitis. Cornea lightly scarred.

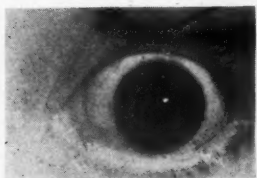


Fig. 9. Keratoconus. Fine central opacity. Concealment completely excised.

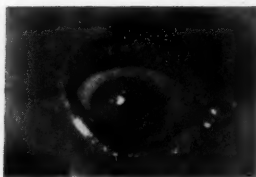


Fig. 10. Corneal Dystrophy (Fuchs). Graft subsequently became involved in dystrophy.

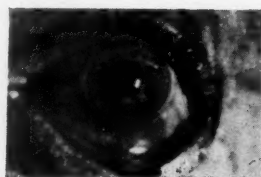


Fig. 11. Dystrophy involving Bowman's membrane principally.

(d) Keratoconus which has progressed beyond the stage wherein vision can be improved by contact glasses or when the lenses are not tolerated. The results in this condition are particularly good if the cone can be completely excised.

2. The unfavorable cases are those of more extensive corneal opacity and vascularization together with damage to the deeper structures of the eye and corneal dystrophies. The percentage of clear grafts is not large in these cases and a certain degree of nebulosity of the graft is frequent. The preoperative vision, however, is worse and even modest improvement is appreciated. Unfavorable conditions are:

(a) Ulcers, burns, and deep infiltrating diseases which have produced extensive and deep opacities with vascularization and have left no normal cornea. These corneas may be two to three times normal thickness, a condition which may be determined by palpating the anesthetized cornea with a probe or in more transparent areas by the slit-lamp. In some cases a superficial keratectomy may be done with the object of removing the superficial dense opacity and vascularization and thus improving the cornea of the host for subsequent keratoplasty. The superficial keratectomy itself may improve the vision to an appreciable degree.

(b) Interstitial keratitis resulting in marked opacity and thickening of the cornea.

(c) Trachoma with pannus and extensive opacity.

(d) Adherent leucoma is an indication of damage not only to the iris but often the rest of uveal tract, lens and retina. When anterior synechiæ are present they may be excised at the time of keratoplasty. The iridectomy should be extensive and all around so that the iris cannot become incarcerated in the wound.

(e) Glaucoma. Even though the intraocular pressure has been brought to normal by operation, the tension is again likely to rise after keratoplasty.

(f) Aphakia, especially after intracapsular extraction. In the absence of the lens, vitreous almost invariably insinuates itself in the wound and causes nebulosity of the graft. The prognosis is better when the vitreous is fluid than when normal.

(g) Dystrophies. Zonular opacity, dystrophia adiposa and Fuch's dystrophy almost invariably invade the graft. In the other dystrophies the graft may remain clear or at least clearer than the original cornea.

COMMENT

Corneal transplantation is now a proven procedure in ophthalmology. Sufficient experience has been accumulated upon which to base the selection of cases and to predict the outcome with reasonable certainty.

INGESTION OF LYE—A SERIOUS PROBLEM

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WE fully realize that the average practitioner is rarely confronted with the problem of lye ingestion by either adult or child; however, the astonishing number of such cases admitted to the John Gaston Hospital (19 in 1946) indicates that the problem is one which should be understood by all. The number of cases which are brought to the hospital only after stricture formation has occurred likewise indicates that the seriousness of ingestion even of minute amounts of lye is not realized by many parents and by an appreciable number of medical men. The present day impression that lye, a powerful caustic, is no longer a common household article is an erroneous one, at least in this section of the South. It is for these reasons that we feel a brief review of the clinical findings in such cases and an outline of the treatment regime used with increasing success at this institution is apropos.

In reviewing the histories of a large number of cases of lye ingestion, the fact has been impressed upon us that the opinions of parents, grandparents, maids, etc., as to the amount of lye actually ingested is wholly unreliable. In a number of cases displaying severe esophageal burns the parents have insisted that the child only touched to his tongue a lye-coated spoon or stick and "could not possibly have swallowed any lye." It appears that in such cases even a minute amount of the corrosive substance mixes quickly with the saliva and when swallowed exerts a powerful chemical effect upon the mucosa with which it comes in contact. It is also impressive that absence of ulceration of the mucosa of the mouth, tongue, and pharynx does not necessarily indicate freedom from damage to the esophagus. In any event the primary and extremely serious problem is the localized effect upon the tissues involved. It has been well demonstrated in this series of cases that the danger of lye ingestion dwells in its local tissue corrosive action and not in any systemic toxic effect as a result of absorption. Furthermore the tissue damage by this chemical agent is limited to the portion of the alimentary canal above the stomach since the normal acid content of the latter organ quickly neutralizes the lye. The few early deaths

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in this series of cases have been due to: (1) aspiration of lye solution with resultant severe pulmonary edema, (2) massive necrotizing esophagitis with death in less than one week, or (3) shock. The local tissue reactions in the esophagus vary much the same as chemical burns of any part of the body. After numerous esophagoscopy studies of all stages of burns resulting from lye ingestion, it has become routine in this institution to classify them in the following manner:

(This classification is based upon the combined ideas obtained from repeated esophagoscopy examinations of the same burned area throughout the period of treatment and the appearance of lesions seen for the first time in their late stages.)

A. EARLY (within 48 hours after ingestion)

1. *Mild burns*

Hyperemia of the mucosa with increased secretion of mucus.

2. *Moderately severe burns*

Marked edema of the mucosa with large amounts of serum and mucus which are grossly bloody. Scattered areas of grayish discoloration are seen.

3. *Severe burns*

Areas are extremely edematous, "meaty" appearing, or grossly necrotic with impending slough.

B. INTERMEDIATE (48 hours to one week)

1. *Mild burns*

The healing stage of A-1. The mucosa appears almost normal although it is somewhat shiny and bleeds easily when touched with applicators or esophagoscope.

2. *Moderately severe burns*

Areas from which the mucosa has become denuded leaving a raw granulating surface upon which granulation tissue rapidly builds up. These lesions may become strictures.

3. *Severe burns.*

Deeply ulcerated lesions with necrotic bases and filled with whitish-gray exudate. Hemorrhage, perforation, and mediastinitis are likely. Stricture is inevitable in such cases.

C. LATE (2 weeks to 2 months)

1. *Healed lesions with no stricture*

2. *Non-epithelialized lesions*

Large granulating areas in which rapid growth of granulation tissue interferes with mucous membrane regeneration and scar tissue contraction is beginning in the base of the lesion.

3. *Epithelialized lesions*

The mucosa has been repaired but is raised and protrudes in folds into the lumen to form rapidly contracting bands or bars as the scar tissue contracts.

D. PARTIAL OR COMPLETE STENOSIS OF THE ESOPHAGUS (over 2 months)

Healing is complete; scar tissue contracture has occurred, and the esophagoscope encounters a rapidly narrowing lumen, most often concentric, to a point where the esophageal wall is greatly thickened, firm, and will not allow passage of the scope with any degree of safety. A small Jackson esophageal dilator passed through this constricted lumen gives a sensation of firm resistance which causes the careful operator to hesitate.

In the not too distant past, the pathologic processes described above occurred all too frequently in regular sequence with the tragic result that the patient with a non-fatal initial burn often developed inability to swallow, became emaciated, and died of starvation; or, reporting late for medical attention, could only be offered permanent gastrostomy as a life saving procedure. Some time later with the development of the Tucker retrograde dilators new hope was offered to the patient with an esophageal stricture. With frequent retrograde dilations via gastrostomy stoma, an esophageal lumen which allowed passage of soft to solid foods could be maintained with comparative safety. It is not intended to imply that all cases of beginning stricture or partial stricture of the esophagus required gastrostomy since it is known that some of those cases were successfully dilated by the antegrade route with various types of dilators. This, however, was always a hazardous procedure and carried a high mortality rate as well as a poor prognosis for complete recovery. The ever present danger of mediastinitis from esophageal perforation which accompanied the older methods of antegrade dilations was relieved by the introduction of the retrograde method. The outlook even then was far from pleasant since these dilations must be continued at frequent intervals for a period of from 3 years to the remainder of the patient's life. A much better solution lay in the realization that perfection of the *early* treatment of even small esophageal burns could prevent these later drastic measures. In those cases which for any reason were allowed to progress to stricture formation, gastrostomy and retrograde dilations offered the only hope

until the recent development of transthoracic surgical technic for resection of the strictured portion of the esophagus followed by end-to-end anastomosis. There are many pitfalls in this method to date although rapid progress is apparently being made. The latter method of dealing with strictures can be applied only to those which occur in the lower third of the esophagus. This will not benefit from 30 to 50 per cent of all stricture cases.

To return to the problem of early treatment of lye burns and the prevention of stricture formation, a strict routine has been developed at this institution for the care of all *known* or *suspected* cases of lye ingestion. This routine is based on the method of Salzer, using the mercury or lead filled bougies for antegrade dilation. The danger of esophageal perforation is largely avoided by use of this type bougie since the weight of this flexible dilator alone is depended upon to carry it through the esophageal lumen. No pressure or force which might push it through the delicate esophageal wall is applied. A greater safety factor lies in the early use of this type dilator prior to the beginning of stricture formation, the purpose thus becoming one of prevention of scar tissue contraction and resultant stricture formation rather than one of dilation of a formed stricture. The histopathologic changes which occur in the esophageal wall following the burn are such that the prevention of stricture formation is possible if measures are instituted early. These tissue changes, outlined briefly, are:

As in burns of any other part of the body, the type of tissue repair depends upon the depth and extent of tissue damage. In the case of minor esophageal burns when damage is confined to the mucosal layer, normal regeneration occurs without the formation of scar tissue. In this case stricture does not occur. If, however, the lye penetrates to involve the sub-mucosal and muscular layers of the esophagus, the reparative process is not nearly so simple. As a result of deep burns the involved mucosa becomes desquamated and cast off, leaving the deeper layers exposed. The tissue cells of these layers are coagulated and destroyed by the chemical action of the lye and a normal inflammatory reaction is set up in the tissues. Providing complete necrosis of the esophageal wall in the involved area does not occur, tissue repair begins after a variable length of time, in the usual manner; a brief review of which may lead to better understanding of the rationale of treatment. Following the acute inflammatory reaction, the formation of new blood vessels begins to take place and numerous fibroblasts appear in the tissue. The fibroblasts immediately begin the formation of loose fibrous connective tissue to fill the defect produced by sloughing of the

tissue which was destroyed. New blood vessels ramify freely in this tissue, producing the extensive granulations so commonly seen through the esophagoscope. The new tissue at this stage has practically no tendency to contract; however, with the increasing deposition of collagen into the fibrous tissue, which begins to occur early, and the disappearance of many of the young blood vessels, relentless contraction of the fibrils begins. The esophagus being a tubular organ, it is apparent that unless the contraction of these fibrils can be prevented or controlled, narrowing of the lumen is inevitable. The early use of weighted dilators thus prevents stricture formation in two ways, (1) by breaking up and stretching the collagen-containing fibers as they attempt to contract, and (2) by molding a large lumen and maintaining its caliber until the reparative process is complete. This means that daily dilations must be continued until all proliferation of connective tissue (containing collagen) has ceased, the tissue has become relatively avascular, and epithelialization of the entire area is complete. The method for accomplishing the above results is as follows:

A. IMMEDIATE TREATMENT (within 1 hour)

1. Give patient a small amount of vinegar or weak acetic acid solution to drink. Some of the lye in the esophagus may be neutralized before burns are severe.

2. Order several tablespoonsful of cream or bland oil to be given by mouth every 4 hours for 24 hours.

3. Patient is given a soft diet for a few days after which a regular diet may be given without any difficulty. We have found no evidence that a regular diet has any harmful effect upon the healing of esophageal burns.

4. The mouth and pharynx are inspected for evidence of burn; if none is seen, a laryngoscope is inserted for inspection of the hypopharynx. If burns are present, no further examination is attempted, but procedure number 5 is instituted. Should the hypopharynx appear normal an esophagoscopy, preferably under general (ether) anesthesia, is performed immediately. As the esophagoscope is carefully passed downward no attempt is made to pass beyond the first burned area encountered and procedure number 5 is begun immediately. If careful inspection of the esophagus down to the cardia reveals normal mucous membrane no treatment is indicated, and the patient may be discharged. It is of the utmost importance that no patient be allowed to leave the hospital until the entire procedure outlined above has been carried out.

5. The indications for this procedure are outlined in procedure

number 4, as follows: The weighted bougies (size according to age of patient) are passed by mouth, allowed to fall slowly down the esophagus of their own weight to the cardia, where they are left in place for several minutes and then withdrawn. Usually 2 or 3 bougies of increasing size are passed in quick succession. No further treatment is carried out after this until the following day when the dilations are repeated. Daily dilations are then continued for 10 days to 3 weeks, according to the severity of the burn, before esophagoscopy is repeated; the advisability of further dilations are determined by the findings of this examination.

6. It should be noted that at no time is any attempt made to pass stomach tubes or similar apparatus for purposes of lavaging the stomach. Such a procedure is useless as well as dangerous.

B. TREATMENT OF EARLY AND INTERMEDIATE BURN CASES (prior to stricture formation)

1. The administration of acetic acid and bland oils is of no benefit in these cases.

2. Diet as tolerated is ordered.

3. Inspection of the hypopharynx and esophagus is carried out immediately as in A-4. Location and description of burned areas are entered on the operative sheet at the time of examination. Daily passage of the weighted bougies is begun and continued until the second esophagoscopy is performed, at which time the previously described burned areas are studied. If complete healing of these lesions has occurred the esophagoscope is passed downward in search of burns which were not reached on the first examination, the presence of such areas being positive indication for continuation of daily dilations. In the latter event a third esophagoscopy and, if indicated, a fourth and fifth are performed at 2 week intervals, until all lesions are seen to be completely healed. It has been our experience that regardless of the prolonged period of hospitalization these patients should not be discharged to continue dilations in the out-patient department, since their apparent good health often leads them to believe, to their later sorrow, that further dilations are unnecessary. Two such cases in this series returned to the hospital in less than 3 months with strictures of the esophagus requiring gastrostomy and retrograde dilations. These cases are still under treatment.

C. TREATMENT OF LATE BURN CASES (after stricture formation has occurred)

These patients usually appear with a history of having ingested

lye from 2 to 3 months previously and of having begun regurgitation first of solid foods and, possibly later, of liquids, within a relatively short period of time. They are usually rather emaciated, but do not appear acutely ill.

1. Immediate esophagoscopy is performed and the stricture studied. Practically all these cases will require gastrostomy as the only safe method of treatment. An occasional case may be suitable for antegrade dilation under direct vision through the esophagoscope until a lumen is obtained which will allow safe passage of the weighted bougies. In such cases, however, the problem is actually one of dilation of a formed scar tissue stricture which prolongs the treatment indefinitely. The prognosis for complete cure by this method is poor.

2. If gastrostomy is indicated, the patient is referred to the Abdominal Surgical Service for this procedure. When the stricture is not complete a sterilized silk string (size 4) can easily be passed through the esophagus as the gastrostomy is being performed; it should be done at this time since the esophagus is likely to become completely occluded by the stricture during the period of healing of the gastrostomy. A simple technic for this insertion has been developed as follows: the silk string is sterilized and placed on the general surgeon's instrument tray. After he has opened the stomach and prior to the formation of the musculo-membranous tube from the anterior stomach wall, one of our staff inserts an esophagoscope down to the site of stricture and under direct vision passes a small Jackson dilator distally into the stomach. The string is then tied to the end of the dilator by an assistant who immediately changes his gloves to avoid contamination of the abdominal wound. The esophagoscopist then withdraws both dilator and scope, bringing the upper end of the string out through the mouth. A catheter, passed downward through the nose into the pharynx, is then used to pull the upper end of the string on through the nasopharynx and out the nose. After completion of the gastrostomy, the two ends of the string are brought together and tied, thus forming a continuous loop from the exterior inward through the nose and down through the pharynx and esophagus into the stomach, thence outward through the gastrostomy stoma to the exterior. As soon as the gastrostomy wound is sufficiently healed (from 2 to 3 weeks) this string is drawn through prior to each dilation to avoid the possibility of breaking an old string which has been weakened by the action of the stomach contents. These dilations are performed twice a week with increasingly large dilators until a size F 36 to F 40 is reached, after which they are performed once a week to once every

two weeks according to the condition and degree of improvement of the patient. As has been said previously, the average length of time over which retrograde dilations have been required in this series varies according to a number of factors, but may be said to be over 3 years. These dilations are of course carried out in the out-patient department as soon as the general condition of the patient warrants discharge from the hospital.

3. In those cases presenting such severe strictures that a small Jackson dilator cannot be passed through under direct vision, the insertion of the string must be delayed until the gastrostomy has completely healed. Attempts may then be made to pass a fine fili-form under direct vision or a second esophagoscope may be inserted into the esophagus through the gastrostomy wound, and the two brought as close together as possible. The operator at the head, using the light of the second scope as a guide, may then pass a fine threaded straight needle through the stricture to be picked up and brought out below by the second operator. A larger string may then be tied to the first and pulled through the esophagus to form a loop as before.

4. The possibilities of transthoracic resection of the stricture and end-to-end anastomosis, as a new method of treatment of such cases, has already been discussed in this paper. Should the cervical portion of the esophagus present an imperforate stricture or a stricture of such severity that retrograde dilations offer little hope of complete recovery, an external approach through the neck can be used. The involved portion of the esophagus is resected and an end-to-end anastomosis performed.

The above description of the treatment regime used in this institution further serves to emphasize the importance and urgency of early recognition and care of all esophageal burns due to lye. This method of handling lye burn cases of the esophagus has led to a marked reduction in the percentage of such cases requiring the more drastic types of treatment, as well as to a dramatic lowering of the mortality rate for all lye burn cases. After careful review of all cases of lye ingestion admitted to the John Gaston Hospital during the years 1942 to 1946 inclusive, the following pertinent facts have been recognized:

1. A study of the case histories for the past 6 years reveals that prior to introduction of the modified Salzer technic at this institution, 50 per cent of all cases of lye ingestion seen within 48 hours developed esophageal strictures requiring gastrostomy.

2. Since introduction of this technic in 1943, moderately severe

to severe burns of the esophagus have been demonstrated in 16 of the 48 cases admitted within 48 hours after the ingestion of lye. Gastrostomy has not been required in a single one of these cases. The strict routine as outlined was applied in each of these cases.

3. During the same period, 6 cases were admitted after formation of a definite stricture. Gastrostomy was performed in each case and routine retrograde dilations were necessary. One of these patients has completely recovered, the gastrostomy being closed after 22 months. It should be mentioned that in each case the gastrostomy must remain patent for at least 6 to 12 months after cessation of the dilations. The 5 remaining patients are continuing to receive regular dilations. For this group the average period of dilations is 23 months.

THE DIAGNOSIS AND TREATMENT OF ABDOMINAL PREGNANCY

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ABDOMINAL pregnancy has been one of the difficult problems in obstetrics. We are reporting a series of 12 abdominal pregnancies, with special reference to the confusing problem of diagnosis and treatment. This communication is intended only to report our experiences with this problem. Therefore, an extensive review of the literature is not attempted.

Abdominal pregnancy is usually divided into two types, primary abdominal pregnancy and secondary abdominal pregnancy. The latter is by far the more common. It has been doubted that a true primary abdominal pregnancy can exist. It is thought that the majority of cases of abdominal pregnancy are not primary implantations on the peritoneum, but are secondary to tubal abortion or ruptured tubal pregnancy. The term abdominal pregnancy describes any gestation which is not predominantly intra-uterine or intra-tubal in its anatomic relationship. Gardner and Middlebrook¹ believe that ovarian pregnancy should be a subdivision of abdominal pregnancy rather than being listed as a separate entity, because in well advanced gestations it is impossible to determine whether or not the implantation was primary in the ovary or involved the ovary at a later time.

Primary abdominal pregnancy designates the case in which evidences of origin from a primary intra-uterine or intra-tubal position are absent, and in which the ovary is not involved in the placental site. The frequent observation of decidual reaction on the peritoneum and the not uncommon occurrence of endometriosis certainly allow the possibility of primary peritoneal implantation. However, the number of such proved cases is small. Certain criteria must be met in proving a case of primary abdominal pregnancy: (1) The tubes, ovaries, and broad ligaments must have a normal appearance with no evidence of recent or remote injury; (2) the absence of any utero-peritoneal fistula; (3) absence of intraligamentary rupture of the tube, or penetration of the space between the broad ligaments by the fimbriated extremity of the tubes; (4) the

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presence of a pregnancy related exclusively to the peritoneal surface and no evidence of secondary implantation from a primary tubal or intra-uterine nidation.^{2,3}

Secondary abdominal pregnancy is a continuation of a gestation in the abdominal cavity following primary nidation in the uterine cavity or tube. There are two types: the intraperitoneal and the intraligamentary, depending on whether secondary implantation occurs on the peritoneum or between the layers of the broad ligament.⁴ In the former the gestation sac is formed mainly by inflammatory tissue surrounding the amnion, while in the latter, as the sac enlarges, it displaces the peritoneum upward, and, depending on its position, even from the abdominal wall.

INCIDENCE

We are reporting 12 abdominal pregnancies among 13,926 deliveries, or 1 in 1,160. Gardner and Middlebrook¹ in their review of 280 cases in 1944, found the incidence higher after the thirtieth year and most frequent in the first and second pregnancies. They found that the character of the previous pregnancy has no prognostic criteria which will determine when an abdominal pregnancy will occur.

MORTALITY

Cornell and Lash⁵ published a statistical review of 236 cases in 1932, covering the world literature and 10 cases of their own from 1919 to 1932. The maternal death rate was 14.3 per cent. Fetal mortality was 67.3 per cent. Mason⁶ added 66 cases from the English literature plus 3 of his own from 1932 until 1939. There were 13 deaths in this series, a maternal mortality rate of 18.8 per cent. In analyzing these deaths he found that 5 (22.7 per cent) occurred when the placenta was marsupialized or drained; 11 per cent of the deaths occurred when the placenta was retained; 11 deaths (84 per cent) had drainage; 1 death (2 per cent) had drainage, although the placenta was not touched. There were no deaths in those cases in which the placenta was not touched and no drains were used. Swanson⁷ found 10 cases of abdominal pregnancy in 23,248 births in the city of Detroit. The maternal mortality was 40 per cent, and the fetal mortality was 80 per cent. Lull⁸ states that the mortality rate is generally 30 to 40 per cent for the mother and approximately 50 per cent for the fetus. Bodenheimer⁹ found 3 cases of abdominal pregnancy in 10,000 deliveries at Charity Hospital in New Orleans. In our series there were no material deaths.

DIAGNOSIS

Cornell and Lash⁵ in their report stated that only 35 per cent of the cases were diagnosed correctly prior to the time of operation. A careful history and physical examination will in the majority of cases make a proper diagnosis. There is usually a history of an acute painful episode which corresponds to the tubal rupture or abortion prior to secondary implantation. Pelvic examination will reveal the enlarged softened uterus as is found in ectopic pregnancy and the soft-to-firm mass formed by the extra-uterine gestation. Biologic tests for pregnancy are positive. In the last trimester the small parts of the fetus are often unusually easy to palpate. There is an increased incidence of abnormal positions and presentations in abdominal pregnancy; especially is the incidence of transverse presentation increased. These findings should make one suspicious of the presence of abdominal gestation. At the expected date of confinement, the patient will go into a pseudo-labor. She may complain of pains of increasing intensity at regularly recurring intervals. The reason for this is not known. She may continue to have these pains for a variable length of time. If the condition is not recognized, the pains will stop and the fetus may die. If the patient is operated upon at some future date, the condition may first be recognized. During spurious labor, attempts have been made to dilate the firm, uneffaced cervix in an effort to introduce a bag, because the presence of abdominal pregnancy was unsuspected.

Bermann,¹⁰ in 1925, is credited with being the first to use hysterography in the diagnosis of abdominal pregnancy. Since then, others have reported cases diagnosed by this method. In addition to the injection of an opaque medium into the uterine cavity, others have used uterine soft tissue studies, pneumoperitoneograms and amniography in attempts at diagnosis. Mattingly and Menville¹¹ found the following diagnostic criteria most useful in diagnosing abdominal pregnancy with the use of roentgenograms: (1) the absence of a uterine shadow without the use of an opaque medium using soft tissue technic and studies; (2) the fetus usually high in the abdomen; (3) an abnormal position assumed by the fetus, especially the transverse; (4) in the lateral view of the abdomen the fetal parts are just beneath the abdominal wall; and (5) after the injection of an opaque medium into the uterine cavity, the fetal parts will be found outside of the uterine shadow on the roentgenogram.

Figures 1 and 2 show the roentgenogram on the patient, C. T. Both the anteroposterior and the lateral show the high location and

transverse position of the fetus in relation to the brim of the pelvis without the presence of a uterine shadow which is highly suggestive

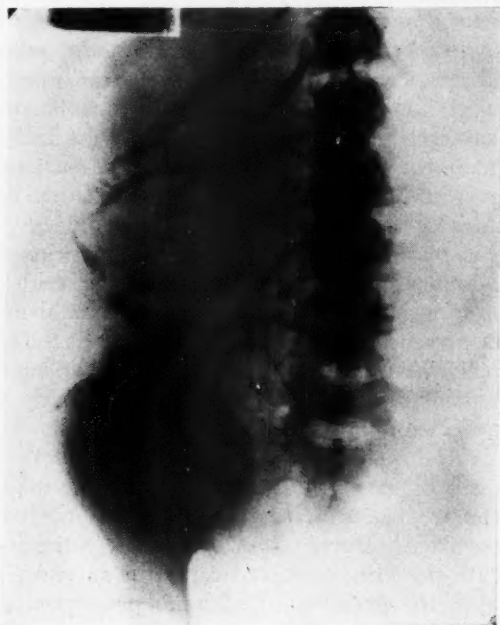


Fig. 1. Anteroposterior roentgenogram showing transverse presentation of the fetus high above the pelvic brim with no uterine shadow.

of abdominal pregnancy, especially when associated with such a history and physical findings.

MATERIAL

A summary of our 12 cases of abdominal pregnancy is as follows:

Age. The ages varied from 19 to 39 years, with the average being 29.4 years.

Color. There were 11 colored patients and 1 white.

Gravidity and Parity. Three of the patients had had no children previously, while seven had had two or less babies.

Months of Gestation. Four of the patients had gestations advanced to 4 months. Three were 5 months, while there was one each at 7 and 8 months. There were three term pregnancies. Three of the infants were born alive, a percentage of 27.2. Seven

were previable or lithopedions, while one was a full term stillborn infant, and the other a macerated premature infant at 7 months. Of the three livebirths, two were term, and the third was an eighth month premature infant.



Fig. 2. Lateral roentgenogram showing transverse position of the fetus high above the pelvic brim and in close proximity to the abdominal wall without a uterine shadow.

Histories. Nine of the 12 patients gave histories suggestive of previous tubal abortion or rupture, i.e., pain, spotting, irregular menses, fainting or marked weakness during early pregnancy.

Roentgenographic Studies. X-ray pictures were taken in 10 of the 12 cases. In 3 of the 10 patients, the films were of no value, while in one the films were interpreted as showing an intra-uterine gestation. In the remaining 6 cases the roentgenograms were of definite value in showing the extra-uterine pregnancy.

Presentation. A transverse presentation was diagnosed in 2 of the 3 term pregnancies and in the premature livebirth. No notation of presentation was made in the other cases.

The *preoperative diagnosis* was made correctly prior to surgery in 7 of the cases. In 6 of these 7 cases the x-ray pictures were of

definite aid in diagnosis. In one case a pneumoperitoneogram was read as showing an intra-uterine pregnancy, whereas all findings on physical examination pointed to an abdominal pregnancy, and the latter was confirmed at laparotomy.

Treatment of the Placenta. In 4 of the cases the placenta was removed. These were early gestations of 4 or 5 months where the fetus had been dead for some time, and the vessels of the placenta were thrombosed and allowed for ease of separation. In none of the term or near-term pregnancies was the placenta removed. Two cases developed abscesses. One drained spontaneously through the original skin incision and after several months improved with no need for further surgery; the other developed a pelvic abscess which was drained through the cul-de-sac of Douglass by colpotomy, followed by improvement and no sequelae. In all other cases when the placenta was left intact, there was apparent absorption with no sequelae requiring further surgery.

None of the cases was drained at original surgery, and no marsupialization was done.

There were no maternal deaths in these 12 cases.

CASE REPORTS

Rather than include the details of all 12 cases in this report, 4 have been selected as interesting clinical problems.

CASE 1. O. P., a 39 year old gravida 3, para 1, was first seen in the Out-patient Clinic on May 13, 1946, complaining of pain of 2 weeks' duration across the lower abdomen. The last menstrual period had been Feb. 10, 1946, and she had started spotting and bleeding 6 weeks prior to the initial visit. Examination revealed pelvic tenderness and a soft cystic 4 cm. mass in the right lower quadrant adjacent to the slightly enlarged uterus. A tentative diagnosis of ectopic pregnancy was made, and the patient was hospitalized. She was in the hospital for 5 days during which time the findings were more suggestive of a tubo-ovarian abscess, and the patient was treated as such and then sent home. She returned to the clinic in June, at which time a Friedman test for pregnancy was positive. The patient continued to complain of lower abdominal pain with nausea and vomiting. A flat plate of the abdomen was suggestive of an extra-uterine pregnancy. The patient was operated upon on July 7. A 5 month fetus was found wrapped in omentum and intestines, which were freed and the fetus removed while the placenta was left in place. The patient made an uneventful recovery and when last seen had no symptoms.

CASE 2. C. T., a 33 year old colored gravida 3, para 2, was first seen Aug. 19, 1946, complaining of abdominal pain. Her last menstrual period had been Jan. 21, 1946, and her estimated date of confinement was October 28, although the height of the abdomen and the rest of the examination suggested an 8 month gestation. The patient was hospitalized for study because of pain. Examination revealed a transverse presentation, and this was

confirmed by x-ray films. A pneumoperitoneogram was misleading in that the report stated that the gestation was intra-uterine. Laboratory data and the rest of the examination were within normal limits. The patient was kept in the hospital, and surgery was held in abeyance despite a diagnosis of abdominal pregnancy because she was symptom-free, the baby was alive, and it was thought advisable to give the baby a chance to attain more maturity. However, the patient went into pseudo-labor on September 22, and laparotomy was performed. A living, premature, 5 pound male infant was delivered. The placenta was not removed, and the abdomen was not drained. The patient was in mild shock due to blood loss following extraction of the baby, but this was quickly combated with blood transfusions. The patient was febrile on her second postoperative day, and from then on was afebrile. She was discharged on the twenty-second postoperative day. At this time she had a localized 7 cm. suprapubic, non-tended mass which was thought to be the placenta. At the time of the last examination the mass had decreased considerably in size, being about 3 cm. in diameter and was causing no symptoms.

CASE 3. M. W., a 32 year old colored, gravida 3, para 0, was seen on July 8, 1946, when she registered for what was thought to be a normal 3 month intra-uterine gestation. At this time she had no definite complaints. She was admitted to the hospital on August 15 complaining of severe, lower abdominal pain, accompanied by fainting and vaginal bleeding. There was a marked secondary anemia. Pelvic examination revealed what appeared to be tissue protruding through the cervical os, and a diagnosis of incomplete abortion was made. The patient was febrile on admission to the hospital, and she was treated as an infected case. Hematin testing of the blood was positive for intra-abdominal hemorrhage, and a tentative diagnosis of ruptured ectopic pregnancy was made on the basis of this test. Colpocentesis and biologic test for pregnancy were negative, while a repeat hematin test was again positive. In view of the continued febrile course of the patient she was not operated upon until October 18. At this time a 5 month calcified fetus was found free in the abdominal cavity with the omentum and intestines wrapped around it. The placenta was adherent to the cul-de-sac and was not removed. The patient developed a cul-de-sac abscess which was drained by colpotomy on the eleventh postoperative day. From then on the patient had an uneventful convalescence and was discharged symptom-free on the 29th postoperative day.

CASE 4. G. C., a 19 year old colored gravida 3, para 2, was first seen in the maternity hospital Sept. 15, 1946, where she was treated as a threatened late abortion at 6 months gestation. Her last menstrual period had been April 30, and the expected date of confinement was Jan. 27, 1947. At the time of admission she complained of lower abdominal pains, but no bleeding or discharge. She improved with bed rest and was discharged to the clinic for further follow-up. An x-ray film was interpreted as showing a normal intra-uterine gestation, and the patient was treated as having a normal pregnancy. Except for a mild secondary anemia, the laboratory data were negative. The patient was re-admitted to the hospital Jan. 2, 1947, in what was thought to be a false labor. At this time a diagnosis of transverse presentation was made, and this was confirmed by x-ray films. The patient was observed until January 5, when she again had pseudo-labor pains. Pelvic examination revealed a hard, long, uneffaced cervix with no fetal pole in the pelvis. Repeat x-ray films showed the same findings as before, and because of the transverse position with a possibility of abdominal pregnancy being entertained, laparotomy was done.

A living female term infant was delivered. The placenta was not removed, no drains were inserted, and the abdomen was closed in layers. The patient had an uneventful, afebrile course and was discharged on her sixteenth postoperative day. At the time of discharge she had a firm 5 cm. smooth, non-tender, suprapubic midline mass. To the present this has receded and has given the patient no symptoms.

TREATMENT

The interesting feature in these cases is the handling of the placenta. The management of the case following diagnosis, and the treatment of the placenta have varied. If the placenta is left at the time of operation, one of several things may happen to it. Usually, the placenta is completely absorbed and causes no further trouble. It may undergo necrosis and subsequent infection to form an intra-abdominal abscess which may later necessitate drainage. It may undergo liquefaction and cyst formation which may require eventual removal. The mass may become calcified as any other foreign body in the abdomen and wall off without causing future signs and symptoms. If the sac remains sterile, the fetus will become inspissated and eventually converted into a lithopedion. Infection of the sac is apt to occur at any time from the bowel, uterus or vagina; infection from the bowel is more likely to occur in the intraperitoneal variety, as here the bowel is usually adherent to the sac wall. The contents of the amniotic sac may rupture spontaneously into the rectum with evacuation of all products.¹² The placenta may become encapsulated by the bowel and omentum which may show remarkable hypertrophy with tremendous enlargement of the blood vessels; obstruction requiring surgery with secondary removal of the placenta may be required.¹³ Before any attempt at secondary removal of the placenta is made, provided an acute emergency does not necessitate immediate surgery, it is believed best to wait from 3 to 8 months after the original laparotomy. This will give the vessels a chance to become obliterated and thus minimize the troublesome and dangerous bleeding. Stilbestrol has been used in large doses to facilitate separation and removal of the placenta at secondary surgery; bleeding was thought to be decreased.¹⁴ Hysterectomy in an attempt to remove the placenta and sac has been attempted.¹⁵

There are three choices of handling the placenta at the time of primary operation. Complete excision of the placenta may be attempted. Marsupialization or partial closure with drainage may be resorted to. Third, the placenta is not disturbed. The first two methods are not usually resorted to in present day surgery, the method of choice being to ligate and sever the cord close to the

placenta which is left in situ. Only the infected cases are drained. In an effort not to disturb the placenta, the incision into the sac should be made over the sac rather than the placenta. If the baby is dead and one can afford to wait, it is best to allow several weeks or months to elapse prior to operation so that the blood vessels can seal off and thus minimize bleeding.

Opinions differ as to the time for operating after the diagnosis has been made. The majority opinion favors immediate operation as soon as the diagnosis is made. This is based on sound surgical judgment as this involves the least risk to the mother. As the gestation continues there is a chance of the fetus dying or of being deformed. Complications to the mother increase with the advance of gestation and the mortality increases also. Some feel that surgery should not be resorted to unless the fetus is dead. Here the danger of sepsis is increased, which outweighs the advantages gained by thrombosis of the placental vessels.

SUMMARY

The treatment of this condition, as has been brought out, is surgical. The successful termination of abdominal pregnancy in these 12 patients depended upon accurate diagnosis and/or the decision that laparotomy was indicated, proper selection of the time to operate in relation to the condition of the patient, and finally, he handling of the placenta. This last consideration is of utmost importance, and it is our rule to leave the placenta undisturbed without drainage or marsupialization unless it is obvious that the placenta can be easily separated and extracted without serious blood loss.

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RUPTURED INTERVERTEBRAL DISCS: PATHOLOGIC, DIAGNOSTIC AND THERAPEUTIC CONSIDERATIONS

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THE symptom complex, the operative findings and the pathologic data upon which the present concept of the ruptured intervertebral disc syndrome is based were first described by Mixter and Barr in 1934. Until that time, ruptured intervertebral disc was an unknown clinical entity; within the brief period of 13 years, it has come to be recognized as the most common cause of low back disability. Opinion as to the proper treatment of patients with this lesion, however, is still widely divergent. Many factors inherent in its mechanism and clinical manifestations are responsible for this divergence of opinion.

An estimate of the efficacy of any form of treatment depends primarily upon the symptomatic relief of the patient. Conservative treatment may only temporarily relieve symptoms, leading to false conclusions as to its value. Again, the effect of any treatment may be influenced by psychologic or financial considerations. The latter may be the only basis for the initial complaint, or, in the presence of a true lesion, for continued disability after adequate treatment. Experience has shown that, in industrial and military cases, both the physical findings and psychologic background of the patient should be carefully evaluated before surgery is advised.

Incidence. Approximately 20 per cent of patients between the ages of 20 and 50 years who present themselves with the sole complaint of low back pain receive a diagnosis of probable injury of the fourth or fifth lumbar intervertebral disc. Of those who complain of low back pain combined with true sciatic radiation, 80 per cent are regarded as having disc injuries with probable protrusion. A statistical study of our cases and a compilation of the reports of others indicate that, of patients with proved herniated discs, 80 per cent are between the ages of 20 and 50. In 95 per cent, the herniation is in the fourth or fifth interspace, approximately 10 per cent more being in the fifth than in the fourth. In 15 per cent, protrusions are found in both the fourth and fifth interspaces. It is now our custom to explore both spaces in every case.

Etiology. According to the authors' conception, the herniated

intervertebral disc is not in itself a clinical entity; rather, it is a mechanical disturbance incident to either of two factors: (1) a single mechanical stress, in a normal or unstable lumbar spine, of sufficient force to produce a rupture with protrusion of the disc, or (2) multiple minor stresses on an unstable joint, with sufficient trauma to the disc to produce degenerative changes in the disc and eventual rupture.

The theory that trauma is the sole cause of rupture of the intervertebral disc has been questioned. It is well recognized that in old age the discs undergo gradual desiccation and degeneration. In generalized atrophic spondylitis, the central portions of the vertebral bodies are compressed, leading to widening of the disc spaces and producing the fish type of vertebra. In this, and in other cases as well, a partial herniation of the disc into the bodies of the vertebrae frequently takes place, giving rise to the condition known as Schmorl's nodules. The prevalence of the lesion in younger individuals, and the location of the herniation in the true ruptured disc, however, are strong evidence against the theory of a non-traumatic origin. Until we have further evidence of primary degeneration of the disc as an etiologic factor, we must assume that trauma, either as a single severe compression or as multiple minor injuries, is responsible.

PATHOLOGY

Rupture of an intervertebral disc takes place at the weakest point in the annulus, its posterior portion adjacent to the vertebral canal, usually along the lateral border. Recent observations have shown that the annulus has a sensory nerve supply and, if injured or abnormally compressed, can produce low back pain without impingement upon the spinal nerve roots. This probably accounts for many minor herniations or central ruptures observed without clinical signs of nerve root injury. The spinal nerve roots lie loosely in the subarachnoid space and, unless adherent to the protruding disc or caught near their entrance to the vertebral canals, permit considerable displacement without symptoms.

The typical sciatic syndrome is induced by irritation of the spinal nerve roots—usually, the root below the interspace wherein the herniation takes place, although both may be involved. Root irritation is caused by direct pressure, by stretching, or by adhesions between the nerve root and the presenting portion of the disc. If the elasticity of the disc is impaired by the loss of the nucleus pulposus, the remaining portion, or annulus, undergoes progressive degenerative changes, with narrowing of the intervertebral space.

Narrowing of the space is accompanied by a settling of the vertebral body, often to $\frac{1}{4}$ inch. This imposes an increased mechanical stress upon the articular facets, leading to traumatic arthritis in the facets and between the vertebral bodies which have been deprived of their insulating pad.

Following destruction of the fifth disc and consequent loss of motion in this articulation, the fourth disc is placed under increased mechanical stress and, sooner or later, may likewise rupture.

DIAGNOSIS

Ninety per cent of ruptured discs may be recognized from the history, physical findings and roentgenographic evidence. If one is in doubt, the diagnosis will often become clear after a period of conservative treatment and observation. The majority of patients who present themselves for treatment in an orthopedic clinic show sufficient changes to warrant an immediate diagnosis of disc injury.

The history and physical findings have been fully described elsewhere and will not be discussed in this paper. The roentgenographic criteria are not so universally understood. For some time following the rupture, the roentgenograms are usually negative, though eventually the narrowing of the affected interspace will become apparent. Time is required for the development of changes which can be visualized in the roentgenogram. By consecutive roentgenographic studies, we have been able to follow the process of gradual narrowing from its incipency to the final stage. In the majority of cases, the narrowing will be observed at the end of a year. Usually, the condensation and proliferation characteristic of traumatic arthritis are demonstrable only after several years.

An interesting and instructive group of patients are those who give a long history of low back pain, which finally subsided. After many years, the original symptoms have recurred and the roentgenogram shows obliteration of the fifth interspace with advanced arthritic changes, while the fourth interspace appears normal. At operation, only some scarring and adhesions, without protrusion of the disc, are found in the fifth interspace. On exploration of the fourth space, a fresh herniation is discovered, being the source of the recurrent symptoms. This picture affords evidence to support the following conclusions:

1. Symptoms from ruptured discs may subside spontaneously and permanently.
2. Ruptures of the fourth and fifth discs may produce essentially the same symptom complex.

3. Destruction of a disc with the development of an associated traumatic arthritis does not of itself cause continuous disability.

In the differential diagnosis of atypical disc lesions, the following should be considered:

1. Spinal cord and meningeal tumors
2. Sacral neoplasms
3. Spondylolisthesis
4. Rheumatoid arthritis
5. Progressive neural lesions, such as syringomyelia and multiple sclerosis.

TREATMENT

Neurologic and orthopedic surgeons generally agree that the majority of patients who exhibit the syndrome of a ruptured disc may be relieved temporarily or permanently by non-surgical measures. Kuhns, in 1941, reported a series of 1000 consecutive patients with low back pain, with and without sciatica, who were treated by conservative means. Seventy-seven per cent were relieved of their pain. In 50 per cent of these, however, the duration of the pain had been 2 weeks or less. Many of those whose symptoms were of longer duration would be regarded by other surgeons as having chronic back disability, wherein disc injuries are the predominant etiologic factor. Our patients who have had a diagnosis of probable disc injury have been treated as follows:

1. Immediate surgical exploration, 10 per cent.
2. Surgical exploration after varying periods of conservative treatment, 20 per cent.
3. Conservative measures (given or advised), 70 per cent.

It is presumed that a number of those for whom conservative treatment was advised or given sought surgical relief elsewhere.

CONSERVATIVE TREATMENT

As a practical plan, we recommend conservative treatment for the following groups of patients:

1. Those having a first attack, either mild or severe.
2. Those having recurrent mild attacks at infrequent intervals.
3. Those over 50 years of age.

4. Those who present some doubt as to the diagnosis or the type of operation to be employed.

5. Those who have recurrent pain following removal of a disc, the treatment being to determine whether the pain is caused by recurrence of the primary rupture, by a secondary lesion, or by some other disease.

The conservative treatment of ruptured intervertebral disc consists of (1) complete rest on a hard bed, (2) physical therapy, and (3) the use of a brace.

For many years, it has been our custom to keep the patient in a horizontal position with traction on both legs. In the vast majority of cases, this has proved satisfactory. Williams and others recommend placing the patient in the Fowler position, with the spine, hips and knees flexed, the purpose being to relax the muscles, relieve tension on the sciatic nerve and to open the posterior portion of the intervertebral space. We have found this useful for patients who do not tolerate the horizontal position.

The period of bed rest varies from 2 to 4 weeks, or until muscle spasm and pain have been relieved, provided operative treatment is not meanwhile deemed advisable.

Physical therapy is begun immediately, with the application of dry heat or moist packs and massage. Carefully guarded active back and leg exercises are instituted as soon as the acute irritability of the back and sciatic nerve has subsided. Graduated reconditioning exercises of the back and thighs should be continued for several months after the patient begins to walk.

A rigid type of back brace should be applied as soon as the patient is permitted out of bed, and should be removed gradually, as the symptoms permit.

If, after 3 weeks of complete bed rest in a hospital, combined with the other measures described above, the patient still exhibits muscle spasm and sciatic scoliosis and pain, and the straight leg raising test is positive, one may assume the presence of a protruding disc with irritation of the nerve root. In this event, further treatment should be based upon a careful study of the patient as a whole. This should include the history as to duration, severity and frequency of previous attacks, the neurologic findings, roentgenologic data, and the response of the patient to conservative treatment. The practical solution for patients, particularly those in the young or middle age group, is surgical removal of the disc, either with or without a lumbosacral fusion. Patients observed during the

first attack, or those in the older age group, may wisely be continued on conservative measures. If the attacks are severe and recur often enough to be disabling, further efforts to bring relief by conservative means are usually inadvisable.

SURGICAL TREATMENT

An analysis of the results obtained by conservative treatment of patients with ruptured discs since 1934, and of the thousands who unquestionably had unrecognized disc lesions prior to that time, proves that the diagnosis of a ruptured disc is not an indication for its surgical removal. The symptoms and the patient's response to conservative treatment are the deciding factors.

Formerly, lumbosacral fusion was performed without removal of probable coexisting protruding discs. The fact that both back and sciatic pain were often relieved indicates that stabilization of the lumbar spine is a definite adjunct to the operative treatment of these patients. In the light of our present knowledge, however, one is no longer justified in performing a fusion without eliminating the possibility of an accompanying disc rupture, by exploration of both the fourth and fifth interspaces. Unless both spaces are explored, it is impossible to determine conclusively whether the protrusion is in the fourth or fifth space, or in both. Failure to remove a protruding disc before fusion may not only result in continued disability, but may render subsequent surgical exploration far more difficult.

The indications for surgical treatment are as follows:

1. Patients with intolerable back and sciatic pain of short duration, who are not relieved by a reasonable period of conservative treatment. Although some of these might ultimately be relieved by conservative means, it is probable that the majority would be saved a long period of suffering and disability by surgical intervention.
2. Patients with symptoms of long duration, who give a history of repeated disabling attacks which have been only temporarily or incompletely relieved by conservative methods. These patients usually present, in addition, positive signs of nerve root damage and roentgenographic evidence of a severe disc protrusion.
3. Patients suffering a prolonged initial attack, or a severe recurrent attack of over 3 months' duration. Experience has shown that such patients will usually have recurrences even if eventually relieved by nonoperative methods.
4. Patients with indications of impending serious damage to the

nerves. These patients, fortunately few in number, are generally found to have, instead of a ruptured disc, some other type of lesion, such as a spinal cord or sacral tumor.

Lumbosacral Fusion Combined with Removal of Disc. There is still no agreement among orthopedic surgeons or between orthopedic and neurologic surgeons as to which patients should have the disc removed alone, and which should have the combined operation of removal of the disc followed by lumbosacral fusion. A decision regarding this controversial issue is urgently desirable. If lumbosacral fusion increases the number of satisfactory results or contributes to the permanency of the results, it should be utilized when indicated. If it does not contribute materially to the patient's recovery, it should be omitted; regardless of the type of fusion, the magnitude of the operation is thereby considerably increased.

In general, orthopedic surgeons agree that, if surgery is indicated, the disc should be removed, though they may regard the protrusion of the disc as only partially responsible for the disability. A pre-existing instability of the lumbar spine may be the primary factor in the rupture of the disc, and this mechanical defect, together with subsequent changes incident to loss of the support of the disc, may cause continued disability after the disc is removed. For this reason, orthopedic surgeons are advising the combined operation in the majority of their cases. Neurologic surgeons, on the whole, hold a different view. In the past, they have advised few fusions in connection with their disc operations. Neurologic surgeons probably see more early cases, yet the problem is fundamentally the same. In many of the larger clinics with departments of both neurologic and orthopedic surgery which function in co-operation, an increasing number of fusions are being performed.

A prolonged follow-up study of a large series of cases will be necessary before sound conclusions can be formulated regarding the advisability of fusion in combination with removal of a ruptured disc. Sufficient time has not yet elapsed for such a study. From observations thus far, we believe fusion should be performed in the presence of the following findings:

1. An unstable lumbar spine associated with a developmental anomaly.
2. Increased mobility of the fourth or fifth lumbar vertebra, which can be demonstrated during the operation.
3. Narrowing of the intervertebral space with local arthritic changes, in young individuals.

4. Recurrence of symptoms following relief by conservative treatment.

Theoretically, the principle of lumbosacral fusion might be extended to other cases (1) to minimize the disability from arthritic changes which eventually take place after most disc injuries, and (2) to prevent recurrent protrusion of the disc in the same interspace, or the protrusion of another disc in an adjacent interspace.

POSTOPERATIVE TREATMENT

In the opinion of the majority of orthopedic surgeons, the protrusion of the disc is only partially responsible for the initial disability. Further, certain physiologic disturbances persist in the soft tissues and bony structures of the back after removal of the disc. For these reasons, the surgeon's responsibility does not cease with closure of the incision; rather, the postoperative care is an important element in the patient's eventual recovery. Supportive treatment consists of the same measures employed in conservative management, including an adequate period of bed rest, carefully supervised reconditioning exercises, and a brace for the lumbar spine.

The average period of disability following removal of the disc alone or combined with lumbosacral fusion is as follows:

Removal of the disc alone:

Bed rest: A minimum of 2 weeks

Time from work: Clerical, 1 month

Labor, 3 months

Removal of the disc combined with lumbosacral fusion:

Bed rest: A minimum of 4 weeks

Time from work: Clerical, 3 months

Labor, 6 months

It should be understood that, although the majority of patients can be relieved of their symptoms and returned to their usual occupations, the spine is never again wholly normal following operation for the removal of a protruding disc, with or without lumbosacral fusion.

INTRATHORACIC NEOPLASMS, REAL AND APPARENT

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APPRECIATION of the significance of homogenous shadows seen in x-ray films of the chest has increased manyfold in the past decade. Interest in the identification of these shadows has increased because a differential diagnosis is more than a matter of academic interest. The medical profession properly pleads with the public to seek examinations which will detect disease in an early, curable state and it is incumbent upon physicians to insist upon a detailed investigation of unusual shadows in the chest with prompt removal of all neoplasms, whether apparently benign or malignant. The advent of mass x-ray surveys gives the medical profession an excellent opportunity to demonstrate intrathoracic masses before their size or malignancy produces symptoms.

The authors believe that in general all intrathoracic tumors should be considered malignant or potentially so and removed as soon as the diagnosis is established, for the following reasons:

1. Benign tumors, although growth may be slow, are confined within a relatively rigid, limited space and will eventually cause severe distress to the patient because of pressure upon important adjacent structures, even to the point of causing death.

2. Many so-called benign tumors will later undergo malignant degeneration. These tumors may grow irregularly, and their growth will be stationary for long periods of time and then, without warning, show a surprising increase in size. By the time such a change has occurred malignant degeneration has already taken place and the patient may well have an inoperable lesion.

3. Malignant tumors must, of course, be removed at the earliest possible opportunity before invasion of contiguous structures or metastasis to distant organs or lymphatic glands has taken place. A preoperative determination of the malignancy of a tumor is frequently impossible in the many neoplasms from which a biopsy cannot be safely taken. A popular misconception regarding these neoplasms is that sharply circumscribed tumors are benign, whereas the truth is that the majority of intrathoracic circumscribed neo-

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plasms arising within the lung are malignant, as well as many of those arising within the mediastinum and pleural cavity.

Every diagnostic means should be used to establish the true diagnosis as soon as possible so that definitive treatment can be applied

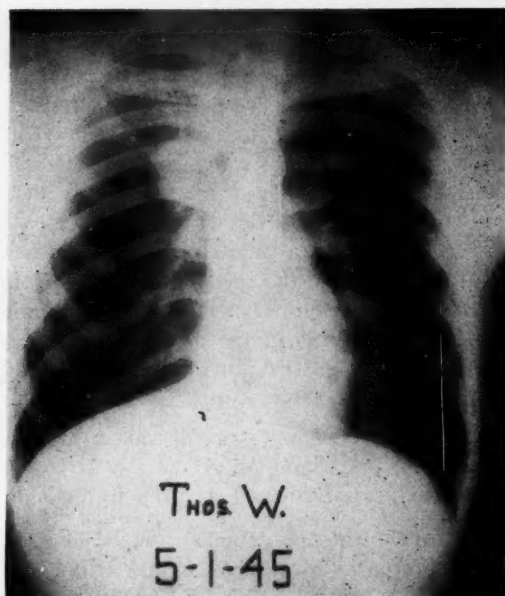


Fig. 1a. Roentgenogram of chest showing circumscribed opacity in right upper lobe. Bronchogenic cyst arising from right upper lobe bronchus.

intelligently. The diagnosis is often obscured by the presence of pulmonary infection produced by interference with bronchial drainage, either by an intrabronchial growth or by pressure upon the bronchus, leading to a false diagnosis of tuberculosis, fungus infection (monilia are often found), "virus pneumonia," or unresolved pneumonia. Lung abscesses often do develop distal to such a bronchial occlusion.

A carefully taken history will often reveal such significant symptoms as a feeling of discomfort or actual pain in the chest; slight to severe dyspnea; wheezing or asthma developing in a pattern atypical of allergic disorders; cough which is at first dry, irritative and unproductive; huskiness of the voice or true hoarseness; difficulty in swallowing; polyarthritis; or expectoration of a little sputum streaked with blood.

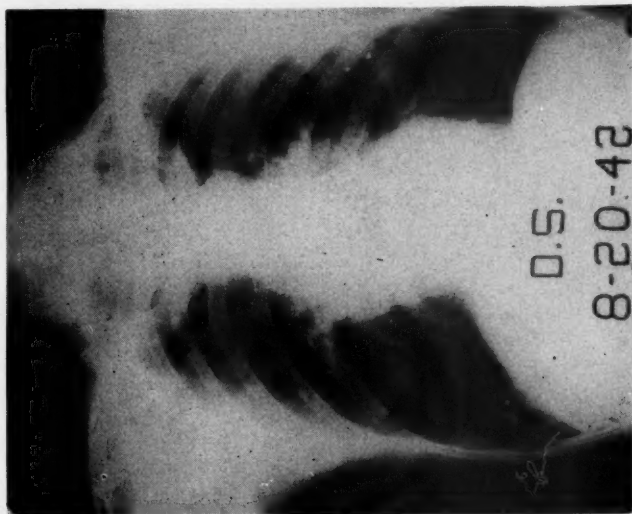


Fig. 1c. Roentgenogram of chest showing circumscribed opacity projecting out from right hilum. Pneumonectomy. Carcinoma of bronchus. Four and one half year survival.

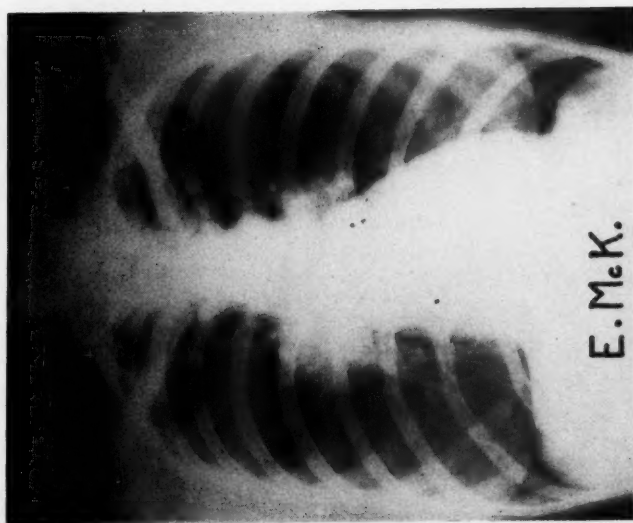


Fig. 1b. Roentgenogram showing circumscribed opacity in right hilum. Following pneumonectomy pathologic examination revealed tuberculoma.

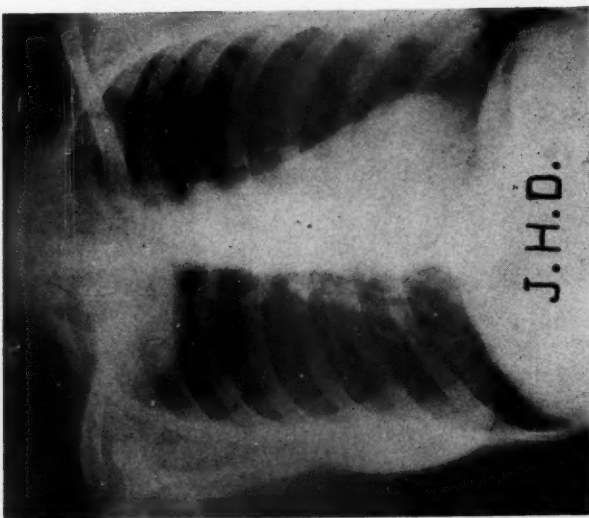


Fig. 2a. Extrapleural mass in right apex discovered on routine x-ray. Patient had no symptoms. Exploration revealed neurofibroma. Specimen showed no evidence of malignant degeneration.

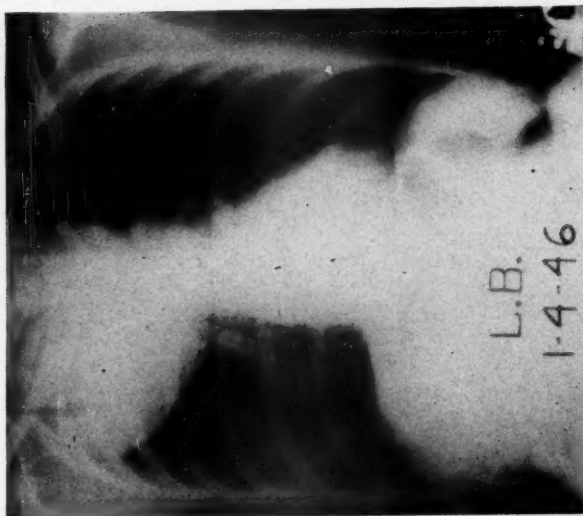


Fig. 2b. Mass in right apex discovered following brassy cough and pain in right upper chest. Specimen revealed "myxoma of mediastinum," but malignant invasion prevented total extirpation.

In the physical examination particular attention should be paid to superficial lymph nodes, a biopsy of which may reveal the diagnosis of the chest tumor itself. The eyes may reveal a Horner's

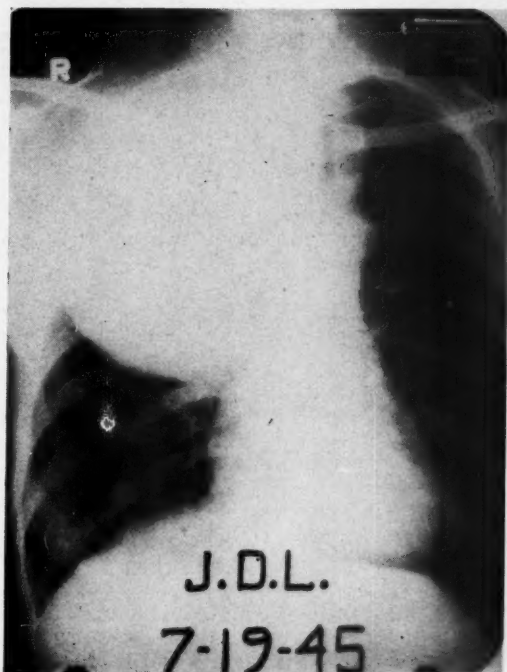


Fig. 2c. "Benign" tumor of right upper chest observed for 7 years with recent rapid increase in symptoms. Only partial extirpation possible because of malignant degeneration and invasion of surrounding structures.

syndrome, and indirect laryngoscopy will indicate paralysis of one vocal cord in many cases with hoarseness. Fluoroscopy is of aid in determining whether or not one leaf of the diaphragm is paralyzed due to involvement of the phrenic nerve. A careful general examination should be carried out to rule out so far as is possible any primary neoplasm to which the chest tumor might be secondary.

Roentgenographic aids in making a differential diagnosis can be obtained from x-ray films exposed in various positions, particularly the posteroanterior, oblique and lateral projections. Recumbent films are useful when fluid is present in the pleural cavity. Bucky technic is a valuable adjunct to outline tumor shadows behind the heart or in the diaphragmatic sulcus, and to demonstrate the pres-



Fig. 3a. Tumor mass in right chest known to be present for 6 years, "Watched closely" for 2 years without change. Four years later tumor is much larger and invades contralateral pleura and pericardium.

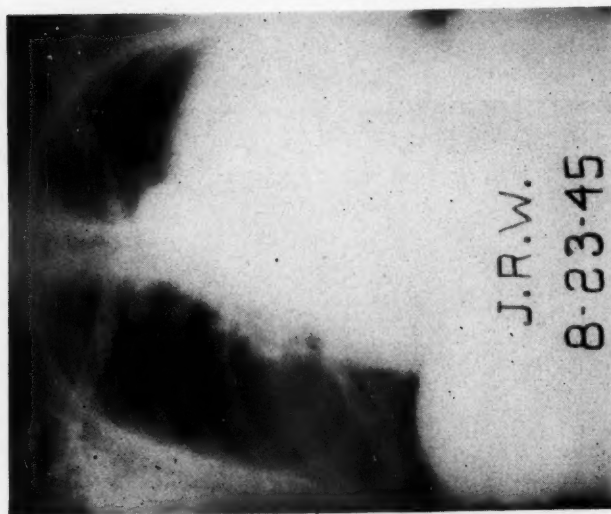


Fig. 3b. Large circumscribed mass protruding from left mediastinum. Readily removed, revealing neurofibroma, benign.

ence or absence of bone invasion. Films made following the induction of pneumothorax or pneumoperitoneum, or the aspiration of pleural fluid with replacement by air, are occasionally useful. Roentgenograms made with the bronchi outlined with iodized oil help to

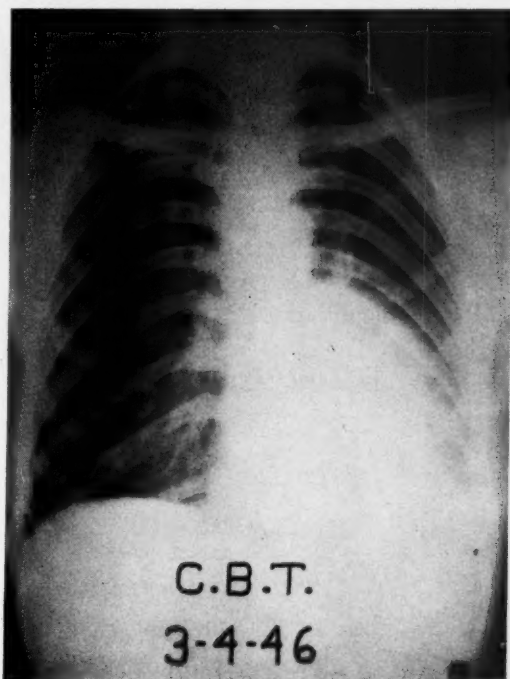


Fig. 3c. Circumscribed density in left lower chest. Bronchoscopy positive for carcinoma. Pneumonectomy performed and no obvious metastases were seen. Patient died in 6 months from recurrence.

identify intrapulmonary neoplasms. Barium studies of the esophagus are always utilized in the study of intramediastinal tumors, especially when there is a history of dysphagia. Planography has proved of extreme value in certain types of chest tumor. Recently, angiocardiology has been more extensively used to differentiate some types of aneurysm from intrathoracic neoplasms.

Bronchoscopy is indicated in all patients who have atelectasis or who give a history of expectorating blood, or whose tumor is in the region of the major bronchi and mediastinum. Esophagoscopy must not be omitted if there is any possibility of invasion of this organ as indicated by the location of the mass.

Biopsy specimens, not always obtainable at bronchoscopy and esophagoscopy, can occasionally be obtained from lymph nodes in the cervical, axillary or inguinal regions. The hazards attendant upon punch or needle biopsy in the chest limit its use to those patients whose general condition precludes the possibility of surgical exploration.

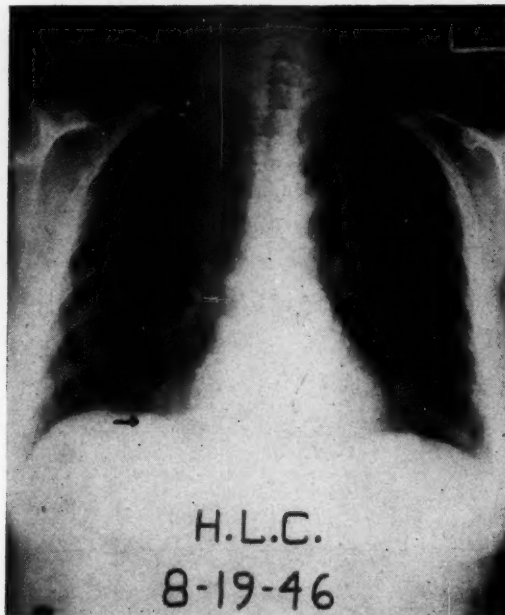


Fig. 4a. Circumscribed density protruding from right anterior mediastinum and producing retrosternal pain. Extirpation revealed lipoma weighing 85 Gm.

Cytologic examination of pleural fluid and of secretions aspirated from the bronchial tree, or of the sputum, contributes often to the correct preoperative diagnosis of malignant tumors.

When all other methods have failed to provide a differential diagnosis, surgical exploration of the chest is a well justified procedure. Improvements in surgical technic, advancement in the field of anesthesiology, the era of chemotherapy and a widened understanding of respiratory physiology make possible the exploration of the chest with the same degree of safety experienced with the procedure in the abdomen.

In 46 such explorations performed by the authors in the past two years there were no deaths directly attributed to the procedure. Only

one patient died less than 3 months following operation, a case of inoperable carcinoma. His life may have been shortened by the operation, death occurring on the tenth postoperative day without any apparent reason except general debility.

To be condemned as a diagnostic procedure is the practice of "watchful waiting" for reasons previously mentioned. X-ray

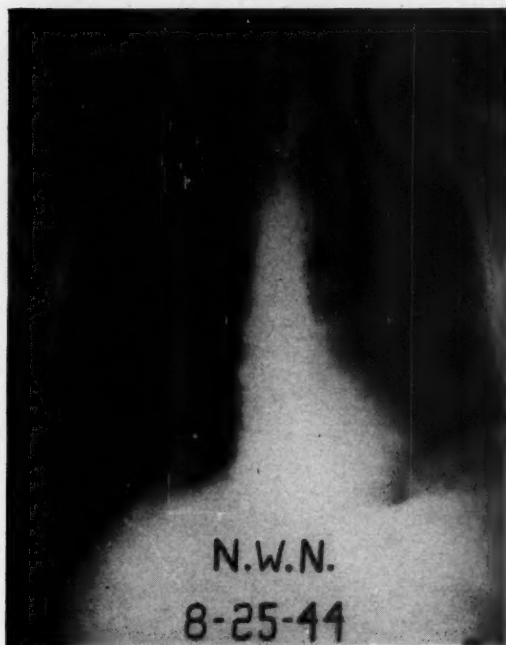


Fig. 4b. Circumscribed density in left costophrenic angle found on survey x-ray film when changing jobs. Exploration revealed diaphragmatic hernia produced by bullet wound 15 years previously.

therapy is likewise to be condemned, as valuable time will be lost, except in cases of suspected or proved lymphoblastoma and for palliation in cases of inoperable malignant neoplasms.

MEDIASTINAL TUMORS

Mediastinal tumors which we have encountered in the past two and a half years include Hodgkin's disease, other lymphomas, primary carcinomas, neurogenic tumors, dermoid cysts and teratomas, bronchogenic cysts, lipomas and non-specific granulomas.

Tumors of lymphatic origin present no surgical indications as

they are best treated with irradiation therapy, nitrogen mustard or irradiated manganese. It is of interest that in 3 of our patients the tumor projected unilaterally from the mediastinum, and in one there were no superficial nodes for biopsy. The diagnosis was strongly suspected from the clinical picture in the last case in which

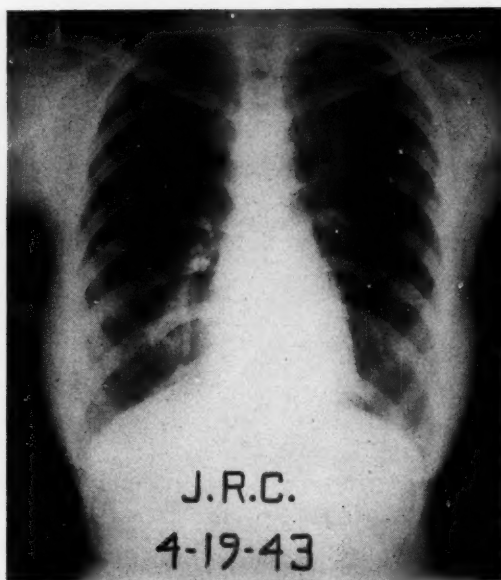


Fig. 5a. Roentgenogram shows small indefinite mass and wedge of atelectasis in right base. Bronchoscopy revealed adenoma. Specimen following lobectomy showed the adenoma to have malignant characteristics at its base.

biopsy was impossible, and rapid resolution with x-ray therapy provided confirmatory evidence.

Dermoid cysts and teratomas, usually considered present at birth, show a marked growth tendency after the age of 20. Both are potentially malignant in that contiguous tissues may be invaded after a certain period in their growth (fig. 3a), making complete surgical removal impossible.

Bronchogenic cysts which are free in the mediastinum usually have a pedicle which is easily ligated and the tumor shells out with the greatest of ease. Those incorporated in the lung itself can likewise be removed without sacrifice of lung tissue in many instances (fig. 1a) although not infrequently lobectomy is necessary. We have found one cyst of bronchogenic origin arising from the diaphragm with no attachment to the lung or bronchial tree.

Tumors of the sympathetic nervous system all arise from primordial cells which migrate in an undifferentiated state from the neural tube to positions in the head and thorax. Therefore, these tumors have more than one type of cell and are hard to classify. They vary from the usually benign ganglioneuroma to the malignant sympatho-

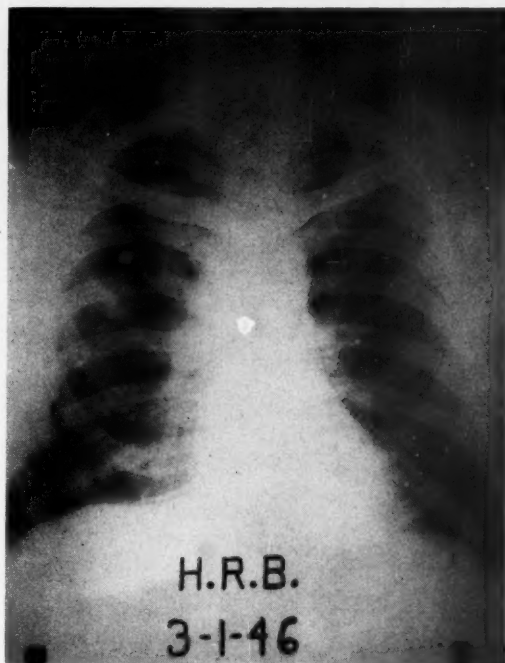


Fig. 5b. Soft circumscribed lesion behind right third rib: Thought tuberculous in spite of negative sputum. Atelectasis of right upper lobe developed and second bronchoscopy revealed inoperable bronchogenic carcinoma.

blastoma, with a strong tendency to become more malignant as time passes. It is imperative that these be surgically removed as early as possible without waiting to observe their growth characteristics.

We removed one pedicled, encapsulated undifferentiated carcinoma from the mediastinum in one patient whose mass had been found in industrial survey x-ray films. There had been no symptoms and to date no evidence of carcinoma elsewhere has been discovered.

INTRAPULMONARY TUMORS

Intrapulmonary lesions of neoplastic origin or resembling neoplasms in our series include carcinoma of the bronchus, metastatic

carcinomas, metastatic sarcomas, superior sulcus (Pancoast) tumors, bronchogenic cysts and tuberculomas.

Carcinoma of the bronchus is the most frequent intrapulmonary tumor found to produce atelectasis or sharply circumscribed shadows in the periphery of the lung. However, it frequently casts no

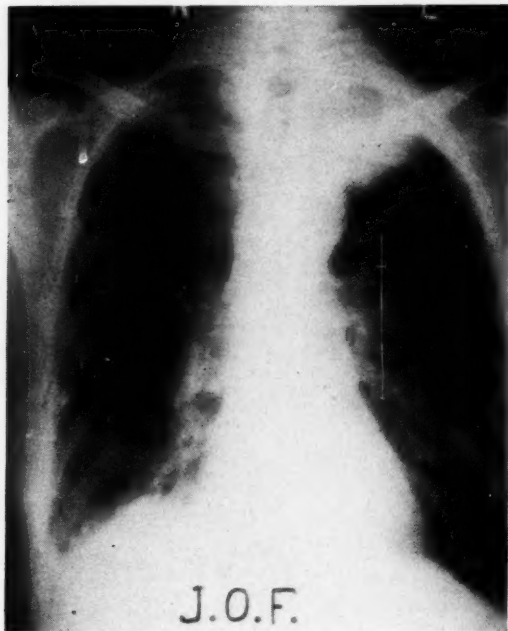


Fig. 6a. Homogenous density left superior mediastinum. X-ray shows destruction of third rib posteriorly. Horner's syndrome present. Diagnosis: Superior sulcus tumor. No operation.

shadow on the x-ray film and is found only at bronchoscopy which is performed because of the presence of one or more of the cardinal symptoms of this disease: 1. cough, 2. wheezing, 3. pain or discomfort in the chest, and 4. expectoration of a small bit of blood-streaked sputum.

Surgical extirpation by pneumonectomy is the only cure for carcinoma of the bronchus, but as yet relatively few patients come to surgery before metastasis to regional lymph nodes has taken place. Although the mortality rate of operation is less than 10 per cent, the number of patients with recurrence and the number explored and found inoperable is disappointingly high. Palliation to a greater

or lesser degree may be obtained with the use of x-ray therapy or nitrogen mustard treatment.

Metastatic carcinoma from extrathoracic organs presents only a problem of diagnosis, as surgical intervention is not indicated.

Occasionally, lobectomy or pneumonectomy is indicated for single

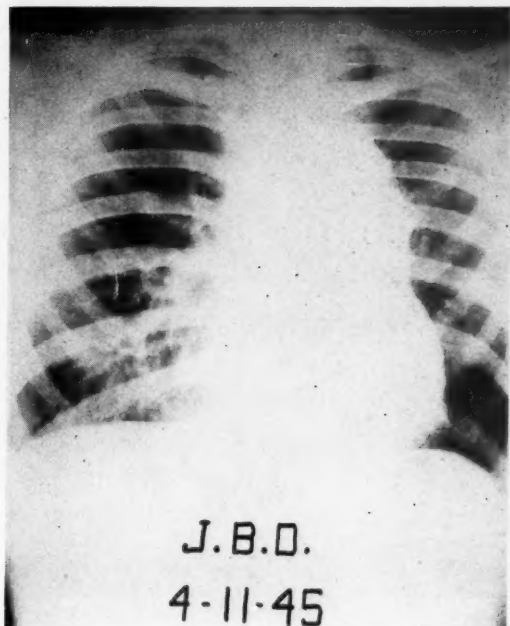


Fig. 6b. Unilateral mass protruding from left superior mediastinum. Biopsy of supraclavicular lymph node revealed Hodgkin's disease. Temporary improvement with deep x-ray therapy.

metastatic lesions in the lung. We have operated upon 2 patients who had previous amputations for fibrosarcoma and osteogenic sarcoma, being unable to demonstrate other lesions. Because of the grave outlook for these patients we believe operation is justified, although in each of our cases a failure is recorded. A third and more recent case is doing nicely three months after amputation of one leg and a lobectomy.

Superior sulcus tumors (Pancoast tumors) are known to be of varying histologic types. The position of the tumor produces the characteristic symptom of pain down the inner aspect of the arm,

and a Horner's syndrome. Bronchogenic carcinoma is shown histologically in many cases, but a relatively benign extrapulmonary neurogenic tumor may be present. Exploratory operation is indicated if no evidence of bone destruction can be demonstrated.

Bronchogenic cysts, especially if connected with a bronchus by a

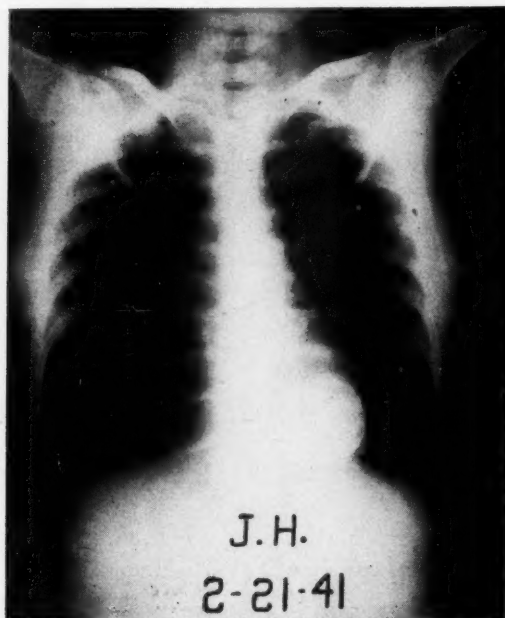


Fig. 7a. Bucky roentgenogram of chest showing round, partially calcified mass behind the heart. Patient exhibited repeated embolic episodes.

patent tract, have a strong tendency to become infected and produce violent symptoms of toxicity. They are best removed, preserving all lung tissue where practicable, but by lobectomy when no true cleavage plane can be developed about them.

Tuberculomas (fig. 1b) offer one of the indications for pulmonary resections for tuberculosis. They are often indistinguishable grossly from carcinoma of the bronchus, even at exploration. Numerous authors report having removed them under a mistaken diagnosis, and our series includes 2 such cases.

EXTRAPULMONARY TUMORS

Extrapulmonary and extramediastinal masses encountered in-

clude metastatic pleural malignancy, bronchogenic cyst, diaphragmatic hernia and sharply localized pleural effusion.

The differential diagnosis of these conditions can usually be accurately made before operation. Metastatic lesions in the pleura produce fluid which is aspirated and examined for tumor cells. They

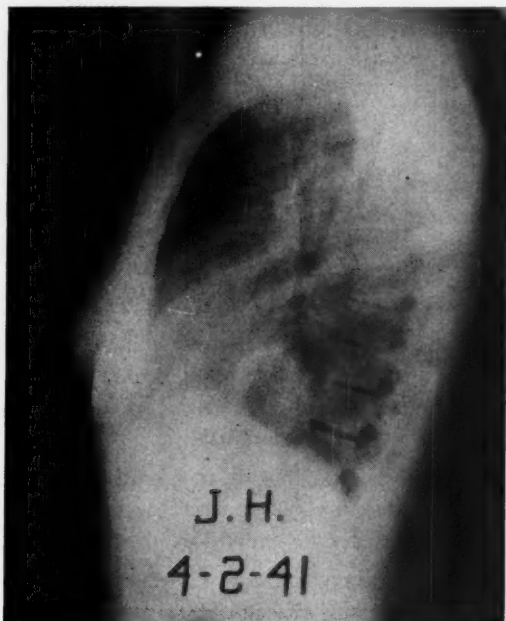


Fig. 7b. Lateral view of same patient. Operation showed congenital diverticulum of left ventricle which was not removed. Death occurred months later from embolus to the brain, a fragment of clot built up in the diverticulum, breaking off into the ventricle.

are outlined when air is returned to the pleural cavity and x-ray films made in various positions. If the masses are large, needle biopsy is relatively safe.

The aspiration biopsy will reveal the presence of a localized pleural effusion, although lateral and diagonal x-ray films will usually make the diagnosis certain before aspiration is attempted.

Diaphragmatic hernias can be outlined with a barium study if they contain bowel and with proper positioning of the patient. When only omentum is extruded above the diaphragm, the true diagnosis may not be made until exploratory operation. Repair through the exploratory incision is readily carried out.

TUMORS OF THE HEART AND VESSELS

We have encountered only aneurysms of the great vessels, aortic and pulmonic, and one unusual case of congenital diverticulum of the left ventricle of the heart (fig. 7 a and b).

The differential diagnosis between aneurysms and neoplasms is sometimes difficult. Fluoroscopic and kymographic examination for expansile pulsation is notably unreliable. Laminated clot in many aneurysms makes pulsation impossible, whereas a solid tumor in juxtaposition to the aorta will exhibit a transmitted pulsation which is quite deceiving. Angiocardiography with 70 per cent diatrizoate is often useful.

If a preoperative differential diagnosis is impossible, exploration is indicated, since tumors must be removed and even aneurysms can occasionally be treated by excision or wrapping with cellophane.

SUMMARY AND CONCLUSIONS

Unusual shadows in the chest as seen in x-ray films are indications for an exacting and complete chest study. A wide variety of neoplasms are found in the chest, many of them malignant, some of them benign with malignant potentialities.

The malignancy or benignancy of an intrathoracic tumor cannot be determined by its roentgenologic characteristics, and a policy of watchful waiting to observe its growth often leads to disaster.

An outline of aids to help make a differential diagnosis is given, but it is stressed that in the absence of an exact diagnosis exploratory thoracotomy should be carried out when a neoplasm is suspected or known to be present, excepting those which are obviously inoperable or which have been proved to belong to the lymphoma series.

Exploratory thoracotomy is a safe procedure in experienced hands, and there is a period in the development of almost any intrathoracic neoplasm when it can be successfully removed.

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THE PRESENT CONCEPT OF THROMBOEMBOLIC VENOUS DISEASE

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FATAL pulmonary embolism has long been regarded as an unavoidable sequel to major surgery in a small but most distressing group of cases. The attitude has prevailed that the hazard of death from pulmonary embolism was one which of necessity had to be accepted by the patient requiring major surgery. Likewise surgeons and internists usually felt that there was little which they could do to reduce the possibility of such a catastrophe. During the past decade this passive attitude has given way to a widespread militant attack on the problem which is resulting in saving many lives. The newer knowledge of the mechanism of thromboembolic disease has resulted in this change in attitude regarding this important problem. The studies of Homans,^{1,2,3} Ochsner and DeBakey,^{4,5,6} Allen, Linton and Donaldson,^{8,9} Fine and Star,¹⁰ Bauer,¹¹ Veal and Hussey,¹² and others have called attention to the importance of the problem, to review current trends in the treatment of the illuminating work referred to there remain a considerable number of surgeons and internists who have not yet fully accepted the implications of these recent studies.

It is the purpose of this presentation to re-emphasize the importance of the problem, to review current trends in the treatment of thromboembolic disease and to give the authors' ideas regarding the most rational method of management of the problem at the present time.

The current literature divides thrombotic venous disease clearly into two types, namely, phlebothrombosis and thrombophlebitis. Phlebothrombosis and thrombophlebitis in our opinion represent extreme variations of the same pathologic process. The division of thromboembolic venous disease into the two types is exceedingly important because of the greater likelihood of pulmonary embolism from phlebothrombosis and consequently the necessity for different forms of therapy.

Phlebothrombosis, a term popularized by Ochsner, DeBakey and Homans, refers to the quiet or bland type of intravascular clotting.

Pathologic studies by Hunter, Sneed, Robertson and Snyder,¹⁴ Rossie¹⁵ and Newmann¹⁶ and radiographic studies by Bauer¹¹ demonstrated that this quiet or bland type of venous thrombosis begins most frequently in the deep veins of the plantar and calf muscles. Homans calls attention to the courses which may be followed by venous thrombosis originating below the knee. The thrombus may remain local without causing any untoward symptoms, it may form a dangerous, propagating, non-adherent thrombus which extends up into the femoral vein and is the usual cause of fatal pulmonary embolism. The thrombus of course may gradually fill the femoral and iliac veins and by resulting obstruction of these vessels produce the picture of the long recognized condition of phlegmasia alba dolens. In such cases for reasons which are not entirely clear there is usually an associated non-suppurative inflammatory reaction in the vein at the groin. In phlebothrombosis the chief abnormality appears to be one of intravascular clotting, the signs of acute inflammation are minimal and the clot within the vessel wall shows little tendency to become adherent to the vessel walls.

In thrombophlebitis there is an inflammatory reaction which is much more pronounced in the wall of the vessel and in the perivascular lymphatics. The clot within the vessel in such cases is much more likely to become adherent and therefore pulmonary embolism in frank thrombophlebitis is much less likely to occur. Also the inflammatory change in the vein wall is responsible for some of the most prominent symptoms in thrombophlebitis. DeBakey⁵ has demonstrated that irritation of the venous segment produces reflex arterial spasm.

Etiologic Factors:

There are numerous factors which contribute to the formation of intravenous clotting. Trauma, infection and prolonged bed rest, are frequently mentioned as playing an important role in the production of venous thrombosis. Wright^{17,18} has pointed out that after surgical operations and parturition the platelet count rises and also states that the platelets become more sticky, thus making it easier for coagulation of the blood to occur. Any condition which favors a slower circulation of the blood through the venous channels naturally favors thrombosis. Homans in this connection stresses the relationship of prolonged bed rest, abdominal distention, enfeeblement of the circulation from any cause, and muscular atrophy of the lower legs. Allen emphasizes that these complications occur much more frequently in elderly and debilitated patients than in the young individual who is in relatively good condition. Certain pos-

tural states favor stagnation of venous blood in the lower extremities. Fowler's position introduces interference to venous return at the knee and also at the pelvis. The pillows so frequently placed beneath patients' knees tend to slow the venous return from the legs. Dehydration with its accompanying increase in viscosity of the blood favors intravascular clotting.

Incidence:

The exact incidence of pulmonary embolism and of phlebothrombosis and thrombophlebitis is difficult to determine. In a discussion of the problem Adams¹⁹ mentions that, from a group of 9,000 patients who underwent operative treatment at the Lahey Clinic, 170 instances of thromboembolic disease were recognized and treated with anticoagulants, and in 8 other cases the complication was recognized and treated by vein ligation. During the same period there were 40 deaths from pulmonary embolism who had no recognized sign of thrombosis or embolism prior to the fatality.

Aycock and Hendrick²⁰ point out that more cases of thromboembolic disease have been reported in Northern States than in Southern States. Many Southern surgeons who are interested in the problem feel that such a difference in incidence is a very real one and is not due simply to a failure to diagnose such cases. It is well known that rheumatic fever and infections of the upper respiratory tract are more frequently encountered in the sections of the country where the climate tends to have more cold and damp weather than in the warmer and drier geographical areas of the nation. In our opinion there is also a difference in the incidence of thromboembolic disease.

At the teaching hospital of the University of Tennessee there are approximately 2,500 major operations performed each year. The number of patients who die in the hospital of pulmonary embolism is only a fraction of that reported by Adams as occurring in a group of 9,000 cases in Boston. If one relied only on record room data of clinical impressions there might be a huge error from the lack of proper diagnosis. However, in recent years the autopsy percentage of the University of Tennessee Hospital has been well over 50 per cent of all patients dying in the institution and, while cases of pulmonary embolism occur, such fatalities are recorded very infrequently in both the clinical and autopsy files.

Allen mentions the high incidence of fatal embolism which was occurring in patients at the Massachusetts General Hospital who were treated for hip fractures. He pointed out that prophylactic

femoral vein ligations had been instituted in such patients thereby greatly reducing such complications.

Boyd²¹ reviewed the findings in 360 patients treated for hip fracture at the Campbell Orthopedic Clinic. The mortality was 7 per cent, and death from pulmonary embolism was not recognized as such in any of the patients who failed to survive. This of course does not rule out embolism in the 7 per cent who succumbed; however, it would make the complication appear to be not frequently found in this group of patients. All of these patients were treated by having the hip "nailed" and therefore they were not immobilized for long periods as would have been necessary for treatment by cast immobilization.

Daniel and Crutcher^{32,33,34} have recently studied the records of patients dying of pulmonary embolism at the Vanderbilt University Hospital in Nashville. Their report is in press at the present time. In a personal communication Daniel states that "It was our impression on the basis of figures you will see in the tables that the incidence of pulmonary embolism is probably as high or almost as high in the South as in the North." In a discussion given before the Southern Surgical Association in 1946 Daniel stated that more than a third of the fatal emboli which he reviewed occurred in patients with incurable disease.

Prevention:

By keeping in mind the causative factors favoring venous thrombosis it is believed much can be done to decrease the incidence of the complication. It is our practice to insist that patients practice leg exercises six times each hour while awake. This consists of flexing, extending and rotating the ankles six times, and of flexing and extending the knee six times each hour while awake. Patients are likewise encouraged to take six deep breaths each hour and it is believed that this aids the venous return. Pillows beneath the knees are forbidden. Careful attention to the state of hydration of the patient is important for numerous reasons. Oschner has advocated the application of elastic bandages from the toes to the groin and has also favored elevation of the foot of the bed in postoperative cases as a method of aiding venous return. The control of infection and avoidance of trauma in the handling of tissue are certainly important.

Early ambulation is generally believed to decrease the incidence of many postoperative complications. Interestingly enough a study by Blodgett and Beattie²² of surgical complications showed no de-

crease in venous thrombosis in patients treated by early ambulation. It has often been emphasized, but probably not sufficiently, that early ambulation should mean just that; namely, early walking and not simply just sitting in a chair out of bed at an early date. The venous return is more impaired by the sitting posture than by being supine. However, ambulation and other muscle exercises are beneficial.

Diagnosis:

The diagnosis of thrombophlebitis usually offers little difficulty. The inflammatory change in the vein wall produces pain. Tenderness and swelling are usually pronounced. Fever is present in most cases. In contrast to this easily recognized condition phlebothrombosis may offer no clues of its existence until pulmonary embolism has occurred. Between the two extremes of the completely silent type of phlebothrombosis and the very outspoken example of thrombophlebitis are all gradations.

Since pulmonary embolism may be the first sign of the difficulty more attention must be given to diagnosing the atypical cases in this group. Small relatively quiet pulmonary emboli may precede the spectacular and often fatal type of embolism in many cases. Such atypical or relatively small pulmonary emboli at times may be confused with pneumonia, postoperative atelectasis, or may be attributed to some cardiac disorder. Sudden pain in the chest, hemoptysis, elevation of temperature, pulse and respiratory rates are all present in some cases. An x-ray film of the chest may or may not reveal the process. The electrocardiogram is helpful in making the diagnosis in some individuals.

In phlebothrombosis there may be tenderness of the plantar surface of the foot and of the calf muscles of the leg. This finding is based on the fact that the thrombosis usually begins in the deep veins in the foot and calf. There may be a slight increase in the size of one calf or ankle and the tissues may be slightly more resistant to compression. Homan's sign, which consists of eliciting pain in the calf muscles from dorsiflexion of the foot, is a test which should be routinely employed. It must be remembered that if early ambulation has been practiced and the patient has been walking without shoes a false positive Homan's sign may be present on both sides as a result of stretching of the Achilles tendon. Careful clinical charts will often reveal a slight increase in temperature and pulse rate which may cause one to search for and find evidences of phlebothrombosis.

Venograms have been reported by Bauer to be of great help in establishing the diagnosis. However, this method has been disappointing to many. In our opinion the normal variations of venous channels is so great that films have been especially difficult to interpret correctly.

Therapy: Treatment of Thrombophlebitis:

As mentioned previously many of the symptoms of thrombophlebitis are caused by vasospasm as shown by the studies of Leriche,²³ Ochsner and DeBailey.⁴ Lumbar sympathetic block is a most useful form of therapy in acute thrombophlebitis because it usually relieves vasospasm and thereby causes the patient to have less pain. Also following sympathetic block the edema often decreases and the skin temperature becomes elevated. Until recently almost all such blocks were performed by injecting procaine hydrochloride into the appropriate sympathetic ganglia. The procaine effect may last for several hours. A more prolonged effect may be produced by using Bromsalizol although this material is more irritating to tissues than is procaine. Recently in patients whose general condition is good we have used tetraethylammonium intramuscularly to block the sympathetic system. In addition to sympathetic block the extremity is treated by elevation. Motion of the extremity without weight-bearing is encouraged. Heat is used where it makes the patient more comfortable.

As stated above, embolism is quite infrequent in cases of outspoken thrombophlebitis; nevertheless it may occur. When emboli do originate from thrombophlebitic foci they are more apt to be of the septic type. If non-fatal emboli arise from a thrombophlebitic leg then proximal vein ligation should certainly be carried out. Some have favored thrombectomy and ligation in such cases. The trend at present is toward ligations at higher levels through normal venous tissue. It seems logical to assume that a thrombus removed from a section of acutely inflamed vein is likely to be followed by a second thrombus.

The problem of the post-phlebitic edematous leg is one which remains to be solved. In our experience such patients have responded very poorly to sympathetic block. The use of an elastic stocking or bandage and elevation of the extremity afford symptomatic relief in many patients but this does not permanently relieve the condition. Recently, femoral vein ligation has been advocated in such cases, the rationale being based on the assumption that the valves have been destroyed in the old phlebitic veins and that the femoral

vein functionally is a varicose vein. We have had no personal experience with this form of therapy.

Treatment of Phlebothrombosis; Vein Ligation:

In cases where phlebothrombosis is definitely diagnosed proximal vein ligation appears at the present time to be the best way to prevent pulmonary embolism. Allen, Linton and others have stressed the value of femoral vein interruption. They advise the removal of any clot which may be present in the femoral vein by introducing a glass suction tip and stress the importance of obtaining a free flow of blood. The superficial femoral is usually the site of division of the vein. This operation may be performed with local anesthesia without great difficulty. The best site for venous interruption has not been definitely established. Allen has also expressed the belief that it is often desirable to perform bilateral femoral ligations even though there is clinical evidence of phlebothrombosis on only one side. Femoral vein exploration on the apparently normal side has on numerous occasions revealed the presence of a silent bland thrombus. Experience has shown that ligation of the normal superficial femoral vein causes very little postoperative swelling or discomfort in most instances. As mentioned above, there is a tendency to perform higher ligations through normal venous tissue as advocated by Veal.²⁴ Homans called attention to the desirability of performing ligations of the common iliac vein in certain instances. Homans called attention to the fact that a more abundant collateral circulation is present after common iliac ligation than after femoral ligation. Ligation of the common iliac, however, is an operation of far greater magnitude than is ligation of the femoral vein. Also in performing iliac ligation it is necessary to use either a general or a spinal anesthetic. More recently vena caval ligations have been advocated by several writers among whom are Veal and Hussey, Linton, Thebout and Ward, for patients who might otherwise require common iliac or bilateral femoral ligations. It has been pointed out by Thebout and Ward²⁵ that vena caval ligations offer less technical difficulty than do common iliac ligations and at the same time offers greater security from embolism.

Edema Following Vein Ligation:

Articles concerned with vein ligation for the treatment of phlebothrombosis have mentioned relatively little about the complications which may follow such procedures, yet in certain instances unfortunate sequelae do occur. Veal mentions that he does not consider that the patient has a normal extremity after a major vein has been

interrupted. As one would expect, postoperative edema is much more extensive where the thrombotic process is extensive than in instances where it is minimal. Veal mentions 4 cases of acute postoperative edema which were relieved by immediate elevation of the limb and by the use of sympathetic blocks. He stresses the value of sending patients home from the hospital with an elastic stocking and emphasizes the necessity of maintaining measures to control edema from the beginning. Dennis²⁶ reported one case where femoral vein ligation was followed by a very distressing fulminating edema of the leg. It was necessary in this patient to open the deep fascia extensively in order to save the leg. There are reports of two chronic leg ulcers having developed in patients subjected to vena caval ligation by Linton.⁷

Prophylactic vein interruption has been advocated by the Boston group as being desirable in a large number of the older patients who are to be subjected to major surgery. This does not seem wise in the Southern section of the country where the incidence of venous thrombosis certainly appears to be less than in the New England area. Prophylactic leg exercises should of course be rigidly carried out.

Anti-coagulant Therapy:

Heparin and dicumoral have been used extensively to prolong the coagulation time of the blood and thus decrease the likelihood of pulmonary embolism. Heparin is expensive, is rapid in producing its effect and is more troublesome to administer than is dicumoral. Heparin has a direct effect on the coagulability of the blood. It is usually administered in an intravenous drip, by divided intravenous doses given several times a day or as more recently advocated by Loewe²⁷ in Pitkin's menstrum.

Dicumoral is inexpensive, is much slower in producing its effect and is given by mouth. Its effect is produced by its interference with prothrombin formation in the liver. Daily laboratory controls of prothrombin time values are necessary if this method is used.

Included among the reports on anti-coagulant therapy are those of Barker, Cromer, Hurn and Waugh,²⁸ Murray,²⁹ Crafoord,³⁰ Loewe,²⁷ Bauer,³¹ de Takats, et al. Hemorrhagic complications have occurred after the use of both drugs. Cessation of heparin and the use of transfusions is the method used to control hemorrhage following heparin therapy. Intravenous vitamin K therapy and transfusions are useful in controlling hemorrhage following the use of dicumoral. These methods may prevent the formation

of clots within the veins but they do not prevent such thrombi as are already present from being dislodged and producing embolism. The routine prophylactic use of anti-coagulant therapy has been advocated for patients undergoing surgery but this certainly would introduce many complications unless administered most carefully under constant expert supervision. It may be fairly stated that the relative value of vein ligation and anti-coagulant therapy at the present time is not definitely established. Both methods have saved lives from death due to pulmonary embolism but the relative merits of the two varied approaches to the problem must be further evaluated in the future.

SUMMARY AND CONCLUSIONS

1. The etiologic and pathologic features of thromboembolic venous disease have been reviewed.
2. Thrombophlebitis and phlebothrombosis are believed to be extreme variations of the same pathologic process.
3. Pulmonary embolism is far less likely to occur in frank thrombophlebitis than in phlebothrombosis.
4. Acute thrombophlebitis is best treated by sympathetic block, elevation of the extremity, motion without weight-bearing and the use of heat where it makes the patient more comfortable.
5. Phlebothrombosis which can be definitely diagnosed is probably best treated by vein ligation at the appropriate level.
6. In patients who have had one non-fatal attack of pulmonary embolism, vein ligation at the appropriate level should certainly be done without delay, provided one has evidence of phlebothrombosis.
7. In the authors' opinion prophylactic vein ligation is not indicated in patients treated in Southern institutions since it is felt that the incidence of the complication is lower in this section of the country than in the New England area.
8. Anti-coagulant therapy expertly used will definitely decrease the incidence of pulmonary embolism.
9. Further investigation will be necessary to determine the relative merits of vein ligation and anti-coagulant therapy in the treatment of thromboembolic venous disease.
10. The conscientious use of measures designed to prevent the occurrence of venous thrombosis will result in the saving of many lives.

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ADVANCES IN THE SURGICAL TREATMENT OF CONGENITAL ANOMALIES IN INFANTS AND CHILDREN

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THERE have been significant improvements in the surgical management of certain congenital anomalies within the past several years. In some types of anomalies practically an entirely new field of therapeutics has been opened, with the result that few congenital defects are considered hopeless now and the majority are managed successfully by surgical means.

CONGENITAL ANOMALIES OF THE CARDIOVASCULAR SYSTEM

The first successful operation for a congenital cardiovascular defect was performed within the last decade. As recently as 1937 White¹ in his textbook "Heart Disease" commented, "there is no curative treatment, surgical or medical, for congenital cardiac defects."

Patent Ductus Arteriosus. Gross² in 1939 reported the first successful ligation of a patent ductus arteriosus. Since that time hundreds of ligations have been carried out successfully throughout this country and abroad. It has been estimated³ that there are as many as 20,000 patients with a patent ductus in this country. It is generally agreed that it is unnecessary to operate upon every patient having a patent ductus but rather that operation should be reserved for those children who show evidence of circulatory embarrassment, or who fail to grow or develop normally, or who have already developed subacute bacterial endocarditis. In 1944 Gross⁴ recommended division of the ductus between clamps and ligation of each end. This method should prevent the occasional recurrence that takes place following ligation in continuity, but it might also prove more hazardous in less experienced hands.

Congenital Pulmonic Stenosis. Prior to 1945 "blue babies" afflicted with congenital pulmonic stenosis were considered beyond help, most of these children dying before their tenth year. Blalock and Taussig⁵ in 1945 reported a successful operation for this cardiovascular anomaly which consisted of shunting blood to the lungs by way of one of the systemic arteries arising from the aorta. Preferably, the subclavian artery arising from the innominate artery is anastomosed to one of the pulmonary arteries. Pulmonic stenosis

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is the principal defect which is present in the tetralogy of Fallot. The stenotic pulmonic conus prevents an adequate amount of blood from reaching the lungs for oxygenation, with the result that cyanosis becomes evident in these patients. The by-pass operation enables an increased amount of blood to be transported to the lungs and to a large extent the cyanosis disappears. The child shows improvement, with gain in weight, increased appetite, and the ability to take a normal degree of exercise. The author recently reported two such operations with decided improvement in both children.⁶

Potts⁷ has modified Blalock's procedure by using a special clamp which permits anastomosis of one of the pulmonary arteries to the aorta itself. This technic would probably offer a distinct advantage if it became necessary to operate upon a small child. Its disadvantage would lie in the absolute necessity of determining pre-operatively whether a right or left aortic arch was present. Potts' operation could not be carried out if the side of the chest which was opened did not contain the aorta. Also, the aorta is more friable and does not lend itself as well to suturing as do the smaller vessels arising from it.

Coarctation of the Aorta. Infants with extensive narrowing of the aorta, or complete atresia of the aorta proximal to the origin of the left subclavian artery, usually die shortly after birth. This infantile type of coarctation is frequently not diagnosed until autopsy. The adult type of coarctation is represented by a narrow constriction of the aorta distal to the subclavian artery, and is compatible with several years of life. Collateral blood can be carried in these latter cases, chiefly by way of the subclavian artery, to the aortic intercostal arteries below the constriction in the aorta. These patients may live until early adult life before a failing heart, cerebral thrombosis, or rupture of the aorta produces death.

Blalock⁸ in 1944 and Gross⁹ in 1945 reported successful operations on dogs in which the aorta was clamped, transected and the blood flow reestablished by suture anastomosis. The majority of the dogs were lost, however, with hind leg paralysis because of inadequate collateral arterial circulation during the period that the aorta was obstructed by clamps. Gross¹⁰ and Crafoord¹¹ in 1945 operated upon children with coarctation of the aorta with excellent results. The operative procedure was the same as that used on dogs. In humans with coarctation one is not unduly concerned about the time element during which the aorta is clamped off since sufficient collateral circulation is present to nourish the spinal cord and lower half of the body. We have been able recently to perform

the operation on dogs with a low incidence of paralysis when the aorta was not clamped off for longer than 20 to 25 minutes. This work will be reported later.

Cavernomatous Transformation of the Portal Vein. This form of extrahepatic portal block has received increased attention in the past two years due to the work of Whipple,¹² Blakemore and Lord.¹³ The condition is characterized by the transformation of the portal vein, or its main tributaries, into a mass of small, tortuous interlacing vessels. There is difference of opinion as to the pathogenesis of this condition: some consider that it is the result of an organized thrombosis with racanalization; others consider it to be a congenital anomaly. The condition is often seen in young children and is manifest by splenomegaly, increased collateral circulation, and gastrointestinal hemorrhage.

Unfortunately, still too often, splenectomy alone is performed in patients with cavernomatous transformation of the portal vein and the patient continues to have episodes of hematemesis. Splenectomy in these cases will decrease the blood flow in the portal venous system somewhat, but the obstructive factor is still present after splenectomy. It becomes necessary, in the light of our present knowledge, to determine accurately the type of portal bed obstruction present in these children at the time of operation. Inspection of the portal vein and manometric determinations of the venous pressure of its branches will enable one accurately to localize the block. The treatment of choice in cavernomatous transformation of the portal vein is splenectomy followed by splenorenal anastomosis. This may be done with a nonsuture technic¹³ using vitallium tubes, or the suture technic,¹⁴ anastomosing the end of the splenic vein to the side or end of the left renal vein. These shunts permit the obstructed portal blood to pass into the vena cava. Should splenectomy have been performed previously, then it may be possible to anastomose a branch of the portal vein to the vena cava using a vein graft and vitallium tubes.

A 10 year old boy under the author's care recently had splenectomy performed 2 years before for splenomegaly and hematemesis. The vomiting of blood had recurred periodically after operation and at the time of his last admission to the hospital he had become almost exsanguinated following a hemorrhage of 10 days' duration. At operation 3 weeks later cavernomatous transformation of the portal vein was found with a venous pressure of 480 mm. of water in the branches of the portal vein. Blood pressure in the portal radicals normally varies from 80 to 100 mm. of water. It was

impossible to secure a sufficiently long branch of the portal vein to perform portal vein vena caval anastomosis, and as the patient's condition became precarious it was decided to abandon the operation. Two weeks later he was operated upon again with the intention of using the iliac vein as a graft between the portal vein and vena cava. An extensive collateral circulation had developed, in the meantime, between the gastrohepatic omentum and the capsule of the liver, the so-called hepatopetale circulation, due to the trauma of the operation two weeks previously. The superior mesenteric vein was only one third its former size and manometric readings revealed that the pressure in the portal branches was only 200 mm. water. The operation was discontinued with the belief that adequate collateral circulation was present.

ANOMALIES OF THE GASTROINTESTINAL TRACT

Esophageal Atresia with Tracheo-esophageal Fistula. Progress in the surgical treatment of tracheo-esophageal fistula has been outstanding. The first successful direct anastomosis of the esophageal segments was performed as recently as 8 years ago¹⁵ and several clinics have since accumulated an enviable series of successful cases.^{16,17} Without surgery the condition is incompatible with life. The operative procedures involved are difficult and tedious, but indeed gratifying if the outcome is successful. In most instances local infiltration anesthesia is employed and supplemented with ether if needed. An extrapleural approach through the right chest is favored by most surgeons. Whenever possible, the upper and lower esophageal segments are anastomosed after treatment of the tracheo-esophageal fistula. Where there is more than a 2 cm. separation of the esophageal segments attempts at direct anastomosis will usually be fruitless and indirect procedures must be carried out. These consist of bringing the proximal esophagus out in the neck and entering the abdominal cavity to perform a gastrostomy. Over a period of time, skin or intestinal lined tubes must be constructed to bridge the space between the esophagus and stomach exteriorly.

Pyloric Stenosis. Even though congenital pyloric stenosis was well described before 1800, practically no attention was paid to the condition for over a hundred years. Even in the recent past the mortality remained over 50 per cent, but today, in most well managed children's surgical clinics, the mortality has dropped to a fraction of 1 per cent. This improvement has come about by more prompt diagnosis of the condition, intelligent preoperative preparation, better operative technic and postoperative care. Attention is

now directed towards maintaining body heat on the operating table with a hot water bottle, the prevention of undue exposure, extreme care in separating the pyloric tumor at the duodenal end where it is thinner, and early feeding in the postoperative period.

Intestinal Stenosis and Atresia. Newborn infants who begin vomiting on the first day of life should be suspected of having stenosis or atresia of the small bowel. Until recently, cures for these anomalies were surgical curiosities but such reports are now becoming much more common. If the diagnosis is made within the first 48 hours, before distention takes place, the chances for a successful anastomosis are reasonably good. Anastomosis with fine silk, by-passing the obstruction, is usually preferable.

Reduplications of the Intestinal Tract. In recent months the author has had two patients with reduplication of the stomach on our children's surgical division with successful operative results in both. Such reduplications may occur at any point in the intestinal tract and are often associated with obstruction. In most instances a resection of the accessory viscus must be performed.

Anomalies of the Bile Ducts. Approximately one fifth of the cases of congenital obstruction of the bile ducts are amenable to surgical relief, which means that one out of five patients has a patent common hepatic duct which may be anastomosed to the intestinal tract. In spite of this possibility the first successful anastomosis for congenital atresia of the bile ducts was not performed until 1927.¹⁸ There is not the haste involved in operating upon these infants as in atresia of the small intestine, and infants may live for several months with complete biliary obstruction.

Imperforate Anus. Rhodes¹⁹ in 1933 emphasized that it was unwise to rush a newborn infant with imperforate anus to the operating room, and that water and feedings should be given normally until the terminal bowel descended to its lowest point. Repeated roentgenograms with the baby on its side and the knees firmly flexed against the abdomen will reveal the true level of the rectum. When it is shown that the bowel can not be made to descend further, or has reached the skin, then operation should be performed. In some cases maximum descent will occur in 48 hours, in others it will not take place until the infant is 4 or 5 days old.

We recently operated upon a 10 year old colored girl for imperforate anus. A small rectovaginal fistula was present permitting gas and some feces to escape. Her colon was greatly dilated and packed with inspissated feces. It was impossible to move the fecal column preoperatively by catharsis. At operation the fistula

was excised and the rectum implanted in the anal skin in the usual fashion. A sphincter was present. Ten days postoperatively the fecal impaction was removed under anesthesia. Normal bowel movements began and the colon rapidly diminished to a normal size. There was sphincteric control at the time of discharge from the hospital.

CONGENITAL HERNIAE

Congenital Herniae of the Umbilical Cord. These are emergency cases which must be operated upon within a few hours after birth. These defects have only a thin transparent covering of amnion and peritoneum which perforates after a few hours, permitting peritoneal contents to spill out on the abdominal wall. Peritonitis will then very likely take place. There have been 10 such cases operated upon on the John Gaston children's surgical service in the past 8 years. A small defect may be closed by approximating the abdominal wall in layers after excision of the thin, membranous covering. Experience, however, has shown that the large defects, in small infants, do not lend themselves well to anatomic closure, for the tension upon the intraabdominal viscera may be too great. With such increased intraabdominal pressure vomiting takes place and these infants sometimes die from inanition postoperatively. It is preferable, we have found, in these cases, to close only the skin, which is sufficiently elastic to permit closure. A few years later when adequate fascia is present the hernia may be repaired more satisfactorily.

Diaphragmatic Herniae. Diaphragmatic herniae of major degree in newborn infants should be operated upon without delay. Symptoms of cyanosis, circulatory difficulties, or vomiting should make one suspect diaphragmatic hernia. Hedblom²⁰ in 1925 showed that 75 per cent of the infants having a diaphragmatic hernia died before the end of the first month of life. Early operation, within the first 48 hours, before distention has taken place, should reduce the mortality by 50 per cent or more. It is our belief that the abdominal approach is preferable to the thoracic in infants.

Indirect Inguinal Herniae. Occasionally an inguinal hernia strangulates in early infancy and operation is required. Infants with small external inguinal rings sometimes have herniae which are difficult to reduce and are the cause of considerable concern to the parents. Operation may be performed in these cases as a safety measure. Generally, however, it is better to delay, if possible, until a child is 4 or 5 years of age before repair of an inguinal hernia is done. At this age the tissues can be handled more satisfactorily and

the child will be more cooperative. Obliteration of the sac in infants and children is all that is needed to effect a cure. Transplantation of the cord is to be condemned because of the elevation of the testicle that it produces. Suturing of the conjoined tendon to Poupart's ligament is unnecessary.

SUMMARY

An attempt has been made to reveal the more important advances in the surgical treatment of certain congenital anomalies in infants and children. Within the past ten years many outstanding contributions have been made to this field of surgery. Greater interest of the medical profession in the surgical problems of infancy and childhood is evident by the increase in the numbers of articles appearing in the literature. The improvement in the results is no doubt due to the increased interest shown.

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ACUTE SUBDURAL HYDROMAS

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THE accumulation of excessive fluid in the subdural space is called subdural hydroma.² This fluid is usually clear, may be colorless or yellow-tinged, and may vary in amount from 30 to more than 1000 c.c.⁷ Most commonly such collections occur following fairly severe injuries to the head. They may develop acutely, with high increased intracranial pressure, or insidiously, with interference with the anticipated progress of recovery from the injury.³ It is the clinical picture associated with the acute form which we wish to emphasize in this paper. This condition has not been nearly so extensively studied, or widely publicized, as that of acute subdural hematoma, but its recognition is equally necessary for the proper care of the patient.

There are two theories concerning the mechanism of the production of acute subdural hydroma. It has been held on the one hand that they result from a leakage of cerebrospinal fluid into the subdural space through tears in the arachnoid which take on a valve-like character.^{1,2} The other contention is that minimal bleeding occurs in the subdural space, and that the fluid is attracted in by osmotic pressure as the breakdown of red blood cells produces an increased number of protein molecules. In support of this view are observations where burr holes made shortly after injury failed to reveal any subdural fluid, while excessive amounts of yellow fluid were evacuated on re-exploration later despite repeated spinal fluid drainage.^{4,7} It appears to us that both factors may play a role. The occurrence of subdural hydroma in which the fluid is quite clear and the protein content little elevated, suggests that the first mechanism is operating. When xanthochromic fluid with a high protein content is found, it appears more likely that we are dealing with a form of subdural hematoma at the other end of the scale from solid clot formation. From the clinical point of view, however, the mechanism by which the subdural hydroma is formed is of secondary importance. The significant fact is that these fluid collections do occur in acute head injuries with the production of high increased intracra-

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nial pressure, requiring urgent surgical relief to effect recovery, if not to save the patient's life.

Recognition of the clinical syndrome associated with acute subdural hydromas, as distinct from that seen with acute subdural hematomas, is important because it usually develops sooner after the injury, is commonly accompanied by the early appearance of papilledema indicating rapidly increasing intracranial pressure, and shows prompt improvement when surgical drainage is carried out before permanent brain drainage has occurred. Three cases are presented to illustrate the salient features of the clinical picture and the gratifying results which are obtained by early surgical treatment.

CASE REPORTS

CASE 1. N. G., a 17 year old school girl, was admitted to the Methodist Hospital on April 19, 1947, following a fall of 10 feet to a concrete floor when a board gave way on a float which she was decorating. She struck the back of her head and was unconscious approximately 20 minutes. After regaining consciousness, she appeared perfectly alert but complained of severe frontal headache and also of stiffness of the neck. She vomited several times. There was an acute epistaxis but no continued bleeding or drainage from the nose, mouth, or ears. She was unable to void during the next 12 hours and had to be catheterized, 350 c.c. of urine being obtained.

On neurosurgical consultation the day after reaching the hospital, she was seen to be alert and cooperative but complained bitterly of headache and stated that the light hurt her eyes. Her temperature was 98.6° , pulse 60, respirations 20, and blood pressure 96/68. The skull showed no deformities to inspection or palpation. The pupils and extra-ocular movements were normal. The optic fundi were negative. The cranial nerves were intact. No sensory or motor loss was present. The deep tendon reflexes were present and equal throughout and no pathologic reflexes were present. Tests of coordination were well performed.

X-rays of the skull showed a linear fracture in the right occipital area extending forward into the temporal fossa. It was felt that the patient had suffered a simple skull fracture with concussion and contusion of the brain, but that she should be kept under close observation as a hematoma suspect because of the slowness of the pulse and severe headache.

Over the next 4 days the patient continued to run a very slow pulse. First the left, then the right, optic disc showed evidence of early papilledema. Accordingly, on April 24, burr holes were made in each temporal region under sodium pentothal anesthesia. When the bony opening was made on the right, the dura was seen to be very tense and showed no visible pulsation. When it was opened, approximately 100 c.c. of slightly yellowish fluid spurted out of the subdural space. Only a small amount of fluid was found on the left side. The brain was completely relieved of tension after the procedure and pulsated freely. A rubber tissue drain was employed on the right side for 24 hours and a copious amount of fluid sufficient to saturate the dressing was obtained during that period. The patient's wound healed per primum and she rapidly improved. In the course of 3 days she became alert and experienced much less

headache. The distention of the retinal veins disappeared. She was discharged a week after operation and was asymptomatic from that time on, although a period of 6 weeks passed before the papilledema had entirely receded.

COMMENT

This case illustrates the rapid development of increased intracranial pressure and papilledema which may occur with subdural hydromas, and which may be contrasted with the ordinary development of a subdural hematoma, excluding that type in which there is bleeding of a major character when the clinical picture resembles that of an extradural hematoma. The slowing of the pulse, in this case, was noticeable the second day after injury and the development of papilledema was noted the third day after injury. The ready response to surgical drainage of the subdural space exemplified by this patient is likewise characteristic of subdural hydromas.

CASE 2. J. W., a 16 year old white male, was admitted to the John Gaston Hospital on Feb. 15, 1947. One week before the patient had fallen down a flight of stairs and struck his head. He was unconscious 15 to 20 minutes and had a slight headache the next day. Two days later there was more headache and slight swelling around the eyes which subsequently disappeared. The headache continued, however, and became increasingly severe up to the time of admission.

The patient was seen in consultation by the neurosurgical department 2 days later. At that time his blood pressure was 124/66, temperature 98.6°, pulse 60, respirations 18. Blurring of the optic discs was present bilaterally with engorgement of the retinal veins.

The remainder of the neurologic examination was negative. X-rays of the skull showed a linear fracture involving the frontal parietal bones on the left side.

The patient was watched carefully and later in the day the pulse dropped to 42, he did not seem to be quite so alert, and there was also slight weakness of the right grip as compared to what it had been earlier in the day. The following morning burr holes were made in each temporal region. Approximately 60 c.c. of clear straw-colored fluid was obtained on the left side and approximately 20 c.c. on the right side. Rubber tissue drains were employed for a period of 24 hours during which there was copious drainage. The patient was relieved of his headache almost at once, but he continued to run a slow pulse even up to the time of discharge on the tenth postoperative day. The choking of the optic discs was receding at the time of discharge, and the patient was entirely asymptomatic. He was followed in the out-patient department and one month after the date of operation, the appearance of the optic discs had returned entirely to normal. He was feeling well with only an occasional slight headache.

COMMENT

This patient indicates the insidious onset which may characterize a subdural hydroma which nevertheless is an acute affair. The early

and profound slowing of the pulse is again evident. Characteristic, likewise, is the dramatic relief from headache which many of these patients experience following surgical treatment.

CASE 3. J. O., a 30 year old white male, was admitted to the Methodist Hospital on March 26, 1946, a few hours after being struck over the head by a heavy metal bar. On admission, he was in a semi-stuporous condition and bleeding from the left ear was noted. The blood pressure was 160/80, temperature 97°, pulse 80, respirations 22. No abnormal neurologic findings were noted by the admitting officer except that the Babinski response was thought to be questionable. X-rays of the skull revealed a long linear fracture across the left temporal bone extending into the occipital area.



Fig. 1. Anterior-posterior roentgenogram of the skull in Case 1 showing the type of long linear fracture of the skull extending toward the base frequently associated with acute subdural hydroma.

Neurosurgical consultation was requested the following day. The patient's state of consciousness had improved and he complained of severe left sided headache and soreness of the left side of the skull. There was a little drooping of the left eyelid and slight dilation of the left pupil. The deep tendon reflexes were normal, as was strength and sensation, but the Babinski response on the right was questionably positive. The pulse had slowed from the admission figure of 80 to the upper 60's and during the next 2 days gradually dropped to 52. On March 30 a trephination of the left temporal region was done. A large amount of fluid which was slightly blood-tinged was obtained from the subdural space. There was dramatic improvement in the patient;

his pulse rose to 80 and he became clear mentally. The patient was discharged with slight residual headache but otherwise in good condition on April 7.

COMMENT

This case is remarkable for the development of third nerve signs with ptosis of the left eyelid and dilation of the pupil which are usually thought of as characterizing an extradural hematoma. Scott⁶ has reported a similar experience. The time interval for its development was of course greater than is seen with the average extradural hematoma. The dramatic slowing of the pulse is once more an outstanding characteristic in this case. The impor-

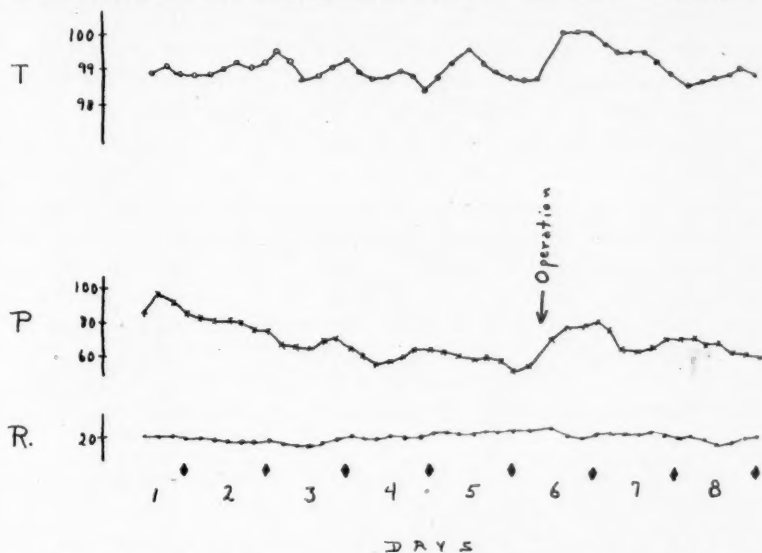


Fig. 2. Chart of the temperature, pulse and respirations in Case 1 showing the marked and early slowing of the pulse following injury and the response following surgical drainage of the subdural hydroma.

tance of repeated careful neurologic examinations during the period of observation in any case of acute head injury is brought out by study of this patient's hospital course. In no other way could the indications for surgical relief have been promptly recognized.

DISCUSSION

In general, acute subdural hydromas make themselves evident clinically less promptly than extradural hematomas or massive acute subdural hematomas. On the other hand, they do develop more acutely than the ordinary subdural hematoma, and evidence

of marked increased intracranial pressure is apt to be found within a period of a few days rather than within a week or two. All the cases cited in this report illustrate the rapid development of increased intracranial pressure in patients who showed very little evidence of severe brain damage, and minimal positive neurologic findings shortly after injury. This is characteristic of subdural hydromas, as is the presence of linear fractures extending into the basilar portion of the skull, likewise exemplified by these cases (fig. 1).

Headache is an outstanding symptom in subdural hydroma, just as it is in cases of subdural hematoma. It frequently develops more acutely, however, and is more likely to appear out of proportion to the degree of injury received. It may be lateral but is more commonly generalized. The almost unbearable character of the headache, exemplified in Cases 1 and 2, is a frequent feature and the relief accorded these patients following surgical drainage is often dramatic.

The early and marked slowing of the pulse with acute subdural hydroma has been mentioned in connection with each of the illustrative cases presented. It is not unusual to see a rapid drop of the pulse to a level of 48 or 50, indicating the immediate necessity for operation. Figure 2, which shows the course of the pulse, respirations and temperature in Case 1, shows very well the typical behavior of the pulse rate preoperatively as well as the ready return to a more normal level following evacuation of the accumulated subdural fluid.

From the standpoint of treatment it is now generally agreed that simple bilateral trephination of the skull is most satisfactory. The temporal regions are convenient sites for the burr holes from the standpoint of maximal drainage.⁷ Subtemporal decompression may be employed,⁸ particularly when there is edema of the brain.

Finally, we wish to emphasize that only by careful continual observation of patients with head injuries can the diagnosis of acute subdural hydroma be made and a satisfactory result obtained through prompt operative intervention.

SUMMARY AND CONCLUSIONS

1. The importance of the recognition of acute subdural hydromas in the treatment of cases of head injury is emphasized. Three cases are presented to illustrate the rapid and severe degree of increased intracranial pressure which accompanies this condition.

2. The clinical picture in acute subdural hydroma develops more

rapidly than that in the usual acute subdural hematoma but less rapidly than the neurologic syndrome associated with extradural or massive subdural hemorrhage.

3. Acute subdural hydromas are characterized by severe headache and early marked slowing of the pulse, both of which frequently appear out of proportion to the apparent degree of brain damage. The early development of papilledema is common. Long linear fractures of the skull also are frequently present.

4. The prompt recognition of subdural hydromas is necessary to prevent permanent brain damage from continued increased intracranial pressure, if not to save the patient's life.

5. The proper treatment of subdural hydroma is prompt surgical drainage of the subdural space.

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THE VALUE OF SKIN TEMPERATURES IN DETERMINING THE SITE OF AMPUTATION IN DIABETIC GANGRENES

Preliminary Report

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WE recently became interested in a method of determining the proper site for amputation in occlusive vascular disease. A survey of diabetic gangrene requiring amputations at this institution during the past 10 years was made. There was a total of 77 cases varying in age from 35 to 85, with an average of 57.7 years. The race was predominantly colored (90 per cent). The sex was more equal (females 62.4 per cent). The extent of gangrene varied from the toes to and including the thigh. Anesthesia was as follows: spinal 32, inhalation 21, intravenous 14, and refrigeration 7. Amputations about the toes were done 19 times and amputations below the knee at the leg level were done twice. Thigh amputations were done 54 times, and 4 were questionable as to the site. The majority had closed amputations (50 cases).

In our group it is obvious that much improvement in regard to mortality and obtaining a more useful stump is desirable and too few cases were amputated below the knee (junction of the middle and upper thirds of the calf). We feel that too many cases in our series had one or more digital amputations, foot amputations, or debridements without success preceding the thigh amputation. Our seemingly high mortality is due to a great extent to the class of patients (90 per cent colored, 100 per cent ward).

Results reported by others appear more favorable as to the mortality and as to the amputation site. This is true in the report of Mandelberg and Sheinfeld.¹ Their mortality rate was 32.8 per cent in a group of 128 diabetic gangrenes from private and ward services, only 43 of whom had thigh amputations. No mention was made as to how they arrived at the site of amputation.

Scott's² method of selecting the site of amputation was based on clinical grounds. His technic did not require oscillometric readings, histamine flare tests or accurate skin temperatures. Amputations below the knee were advised except when there was no pulsation in

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the femoral artery or when cellulitis or gangrene were present above the lower third of the leg. He advised paravertebral blocks before and after surgery and gave spinal anesthesia as the one of choice. He reported 34 cases with amputations below the knee with 5 failures (14.7 per cent). He advised atraumatic surgical technic and avoided tourniquets. He also advised immobilization of the stump. Allen³ when in doubt advised amputation below the knee on the basis that "slow healing was better than no healing." Samules⁴ did not advise routine mid thigh amputation but a supracondylar amputation. He offered no means of determining the level of amputation. Nyström⁵ agreed that the older methods were inadequate (palpation of arteries and skin temperatures by hand), and brought out the fact that satisfactory skin temperature does not guarantee a sufficient blood supply to the deeper parts, especially the bone. Nyström, in selecting his site of amputation, advocated a technic which required freezing small areas at different levels of the extremity with a carbon dioxide stick, the resulting reaction being dependent upon the circulation or the lack of circulation.

Silbert⁶ took strong issue against the dictum which has been taught for years; that is, amputation should be done through the thigh in order to secure adequate circulation. This "rule of the thumb" has also been proved incorrect by surgeons in the past few years, notably McKittrick, Beverly Smith and others. However, Smith⁷ offers no routine for determining the site of amputation. He states that if oscillometric readings are as much as 0.5 in the lower leg, the knee joint can be saved. Smith further states that a functional joint is particularly advantageous in the elderly. Silbert goes further to insist that amputations below the knee may be done even when the popliteal arteries are closed. He states it is advisable to use a so-called circular or guillotine technic in order to obtain a stump sufficient in length below the knee to justify that level. Silbert also reported the fact that painful stumps are more common to thigh amputations than in the midleg.

Massey and Beckel⁸ reported 15 amputations below the knee and 70 above the knee, selecting their site of amputation by exploration of the vessels. Their high rate of amputations discouraged a lower site in the elderly. Solley⁹ in a study over a 5 year period at St. Luke's Hospital, indicates that his selection of the site of amputation depends on adequacy of circulation and severity of infection. Oscillometric readings and skin temperatures were not routinely used and, in his opinion, were entirely unnecessary. Intelligent handling of the time proved method of palpation was considered sufficient and the circulation adequate if the patient's foot was warm

with or without palpable dorsalis pedis pulsations. Little or no pain on bed rest for 24 to 48 hours with proper diabetic therapy was also used as a criterion. He states further that the circulation is judged to be inadequate if the toes and feet are cold and painful, thus reaching the decision of a thigh amputation.

Pennoyer¹⁰ reported observations over a 5 year period at Roosevelt Hospital, and concluded that every case must be treated as an individual problem, using surgical judgment as the chief instrument in determining the site of amputation. However, he thought the pulse, oscillometric readings, skin temperature and rate of saline absorption useful. He stated that in his experience any approach to the sympathetic nervous system had no material value in increasing the blood supply to the extremity. He condemned the practice of routine thigh amputations for diabetic gangrene. De Takáts¹¹ states that most patients after 60 will not learn to use an artificial limb and that a weight bearing stump need not be considered. In determining the site of amputation, he utilizes measurements of skin temperatures and histamine flares. He states that when a thermocouple is not available, the palms of the hands are capable of detecting sudden drops in temperature. De Takáts feels that the skin temperature and histamine flare tests almost invariably point to the same levels. The commonly found edema associated with diabetic gangrene is one disadvantage to the histamine flare test. He has also found that lumbar sympathectomy has improved the circulation at the site of amputation. More recently, de Takáts¹² has reported amputation levels below the knee after a sympathectomy in which circulatory test done before the sympathectomy indicated the amputation should have been done above the knee.

We agree with Ochsner¹³ in that oscillometric readings are of little value in determining the condition of the smaller vessels and we further agree that the skin temperature is a better indication as to the circulation. Ochsner has also brought out the fact that the skin temperature is not always the same as that of the underlying deeper structures. McKittrick¹⁴ has found oscillometric readings and x-ray examinations of no value in determining the site of amputation. He suggests the use of spinal anesthesia or sympathetic blocks in determining the degree of vaso-spasm. Amputation through the upper third of the lower leg he contends may be successfully done on a patient over 70 years of age, who is in good general condition and has good pulsation in the popliteal artery, provided the skin at the level of the incision is in good condition and there is no abnormal temperature or color change and no lymphangitis above the ankle. However, he thought a midthigh amputation

to be the simplest and safest procedure, and that it should be done in most patients over 70 years of age.

Until our recent interest it has been somewhat of a general policy of the Surgical Service to consider most patients with diabetic gangrene, except those cases in which gangrene is limited to the toes, as candidates for amputation above the knee. Due to a desire for greater conservatism we have attempted to work out a procedure which would be more accurate in selecting the site of amputation than previously used empirical methods. A certain number of these cases will sooner or later come to amputation above the knee. However, we are sure a larger number, if handled properly, will tolerate amputation below the knee. These individuals should not be denied the advantage of a stump at a level which proves more useful. It is obvious then that the problem is one of determining whether the patient is best suited for digital and foot surgery, amputation below the knee, or amputation in the thigh.

An early and accurate decision as to the site of amputation, which at the same time will often indicate the advisability of extending or terminating further conservative treatment, will result in lower mortality and morbidity. In approaching this problem we make an attempt to set up a procedure which is accurate and scientific, yet not too complicated to be used by the general surgeons, since a big percentage of amputations done throughout the country will not have the advantage of a teaching hospital. Much thought has been given to work done by others and we have found in our review of the literature of the past 10 years that not a great deal has been contributed to this phase of vascular surgery.

We had primarily two objectives: first, the selection of the proper site of amputation, and second, if possible, the improvement of the site of amputation. We felt that skin temperatures offered the easiest, safest and most accurate means for testing the circulation. Our studies are dealing only with diabetic gangrene in order that we may compare at a later date our results with that obtained with arteriosclerotic gangrene, uncomplicated by diabetes mellitus.

Sympathectomies are not advocated indiscriminately. We considered a rise in skin temperature of 4° following a sympathetic block necessary before advising sympathectomy. After further study and collection of data, we may agree with Luke¹⁵ that even as little as a 2° rise in skin temperature will be an indication for sympathectomy. The diabetic suffering with gangrene is the extremity is fortunate if there is a sufficient amount of vasospasm to justify a sympathectomy, thereby avoiding amputation or lowering

the level of amputation. At the outset we considered using the following in our study of the problem: (1) skin temperature; (2) histamine flare tests; (3) fluorescein; (4) isotopes.

We selected 4 procedures to be used in our study of the circulation (skin temperatures) before and after each sympathetic block, to determine both the site of amputation and whether or not it can be improved by sympathectomy. Our study includes for comparison tetraethyl ammonium chloride, paravertebral block, spinal anesthesia, and caudal anesthesia. The routine use of caudal anesthesia was discontinued as it has proved unreliable in our hands. Most observers agree that spinal anesthesia is the method of choice unless, of course, there is a definite contraindication. With it, both lower extremities may be studied simultaneously. Tetraethyl ammonium chloride also has this advantage. The true nature of pain cannot be evaluated with spinal anesthesia as it can with paravertebral block or with tetraethyl ammonium chloride. The latter has the advantage in that all four extremities may be studied simultaneously.

It became obvious that it was not practical to use the histamine flare test or fluorescein on each patient in our studies, since each had to be tested 6 to 8 times during their work-up. It proved more practical to take skin temperatures as there is no trauma and it can be done rapidly without pain or apprehension. We have had no experience with isotopes of fluorescein. The use of these two agents certainly cannot have the advantage of being without pain or apprehension. We did not find it practical to do our tests in rooms under strict temperature and humidity control.

Our cases will be classified as to the level where amputation should be done, with or without sympathectomies, under the following groups: Digital amputation, amputations below the knee, and amputations at or above the knee. Below the thigh or knee level there is but one level for a satisfactory stump adaptable to prosthesis (we refer to amputations done for occlusive vascular disease); namely, the usual level below the knee at the junction of the middle and upper thirds. Amputation elsewhere is not practical and too hazardous due to normally poor circulation about the ankle and foot for us to consider any other site regardless of the temperature response. In one group, not only digital amputation but ulcerations requiring plastic procedures are included.

At the present, every case for study has received a test dose of tetraethyl ammonium chloride; that is, approximately 5 c.c. intravenously. Skin temperatures at the foot, ankle, midleg, knee and

thigh were taken before and after the blocks. We have found the response to this drug to be similar to that reported by Luke, in that the skin temperature rise after its use usually parallels that following a lumbar block. We have found, however, that occasionally no response is obtained with this drug. For this reason, any negative results with tetraethyl ammonium chloride have been ignored until checked. However, it is our belief that eventually this drug or a similar one may replace the other procedures. For comparative studies, skin temperatures were taken before and after paravertebral block and spinal block at the same levels mentioned above.

We have found oscillometric readings to be of no great value but they offer encouragement if the readings are greater after a block. Our experience with arteriography has been limited, because we feel it is too technical, difficult, of doubtful value, and probably harmful to the patient. This is particularly true when we realize visualization is usually confined to the larger vessels rather than the ones responsible for collateral circulation. Each case is treated individually, depending on the degree of response obtained by sympathetic block. When there is any disparity between the tests used, the spinal block is considered the most accurate. Such conditions as tissue reactions, degree of infection, moist or dry gangrene and lymphangitis have to be considered in evaluating any particular case. The anesthesia of choice is spinal; however, refrigeration anesthesia is definitely indicated in those cases which, when first seen, are in a critical condition. Refrigeration anesthesia is routinely employed in the toxic diabetic gangrenes who obviously must have a thigh amputation due to the extent of their gangrene and infection.

It is not our purpose in this paper to discuss surgical technic, however, we feel there are a few principles peculiar to that of diabetic gangrene. Digits when demarcated, in the absence of infection or moist gangrene, are amputated through the line of demarcation without trauma to the normal tissue, ronguering the bone stump approximately .5 cm. proximal to the granulated stump. We advocate a closed amputation below the knee in the absence of tissue reaction provided the skin temperatures are reasonably high. If the reverse is true and infection is approaching the site of proposed incision, a guillotine type of amputation is in order at this level. However, open amputation below the knee should be avoided if possible. When amputation is indicated above the knee, we do a closed amputation unless there is general sepsis and tissue reaction. In general, we practice a minimal amount of trauma to the tissues, complete hemostasis, and minimal suturing of the deep

structures. The skin and fascia are closed without tension. Penrose drain is used if indicated. No tourniquets are used because we feel that they add unnecessary trauma, and without the tourniquets we are able to judge the patency of the vessels as well as the ability of the soft tissue and bone to bleed. All stumps are dressed with gentle and even pressure without constriction. Wounds are dressed infrequently if the stump has been closed without drainage. Except to remove the drain on the second or third postoperative day, no further inspection of the wound is done unless the patient's temperature and pulse suggest the need, until the sutures are removed between the 10th and 14th day. In the cases where refrigeration anesthesia is used, the sutures are removed much later, usually about the 21st postoperative day.

CASE REPORTS

CASE 1. Mrs. M. J., age 70, 5' 4", weight 160 (a known diabetic). Three weeks prior to admission, on May 1, 1947, a corn on the right little toe had been pared. This was followed by infection. Home treatment was carried on until admission at which time she was septic, stuporous, and her diabetes mellitus was out of control. One year previously massive varicose veins on the left leg had been treated by saphenous and secondary vein ligations with good results. The patient had been making plans to have similar surgery for the varicosities of the right extremity just prior to the onset of her present illness.

Physical examination was irrelevant except for the extremities. There was a moist gangrene of the lateral half of the extensor surface of the right foot with complete destruction of tissue down to the extensor tendons. The fifth toe showed evidence of a corn having been pared. The left lower extremity was fairly normal for the age of the patient.

The patient's skin temperatures were tested before and after spinal anesthesia and tetraethyl ammonium chloride. The skin temperatures of both extremities, discounting those of the right toes which were somewhat elevated due to the inflammation, before sympathetic block were extremely high for an individual of this age, being from 91° at the toes to 96.5° at the thighs. After the blocks, the temperatures of both ankles, midlegs, knees and thighs varied between 93° and 95° .

On the day of admission, under spinal anesthesia, debridement was done and adequate drainage was established.

On May 15, it became apparent that further surgery was indicated as the infection was extending down through the fourth and fifth metatarsals. Under spinal anesthesia, this area was explored and the infection was found to have extended to the plantar surface at which time the leg was amputated at the junction of the middle and upper thirds. The arteries were thickened but bled when cut (no tourniquet was used). All tissues bled freely. It was necessary to use bone wax on the stump of the tibia. The fascia was closed without tension and the skin sutured loosely. A small Penrose drain was removed in

72 hours. Penicillin was given from the time of admission until after the 3rd postoperative day. The sutures were removed on the 12th postoperative day and primary union without infection was obtained. Good function with prosthesis is doubtful but hoped for.

This case is an example of very adequate circulation (temperatures even before the block approached that of the thigh) and if early adequate treatment had been instituted in this case, the foot could possibly have been spared. This case is a type in which a sympathectomy obviously is not indicated.

CASE 2. Mr. T. R. B., age 52, 5' 9", weight 170 (recently known diabetic). Admitted to the hospital on Feb. 14, 1947, with dry gangrene of the fifth right toe. He gave a history of a sudden onset January 3 with severe pain in the right leg from the groin to the knee, which in a matter of a few hours localized in the 3rd, 4th, and 5th toes and became so severe that he was unable to walk. At this time, he was referred to a local clinic by his family physician and was diagnosed as arteriosclerotic gangrene complicated by diabetes mellitus. While there, he received adequate medical care and treatment with pavex and paravertebral blocks. Before this present admission, caudal anesthesia had been attempted elsewhere but was unsuccessful. An alcohol injection had been done in the right paravertebral space about 10 days before he was seen by us, without desired effect. The past history was irrelevant.

Physical examination was essentially negative except for the lower extremities. On admission, he had a dry gangrene of the 5th toe of his right foot with a moderate amount of pain. The pulse in the dorsalis pedis vessels were not palpable. The posterior tibial pulse was questionable and the popliteal pulse was only faintly palpable. Buerger-Allen tests were slightly positive on the left and strongly positive on the right. There were minor trophic changes (lack of hair on the dorsum of the foot and thin, glistening, dry skin).

The venous filling time was 30 seconds on the left foot and 40 seconds on the right foot. Skin temperatures after tetraethyl ammonium chloride rose from 82° to 85° on the right foot and from 86° to 90° on the left foot (average temperatures at the base of the toes). There was a corresponding rise following spinal anesthesia. The venous filling time improved approximately 10 seconds on each foot.

On March 3, the 2nd, 3rd and 4th right lumbar ganglia and chain were resected, after which the temperature of the toes remained at the level which had been obtained with tetraethyl ammonium chloride and the lumbar block (86.5°). The patient had complete relief from the pain. The temperature of the uninvolved leg varied from 4° to 6° lower than the sympathectomized extremity. On March 15, a guillotine type amputation of the 5th toe was done through the line of demarcation. The patient was discharged on March 19 with the toe well on the way to healing. The toe was completely well at the end of two weeks.

This patient was advised to watch the left leg carefully. In the event of impending gangrene he should have this leg sympathectomized. This case demonstrates the value of determining the circulation in the lower extremities of elderly diabetics.

CASE 3. K. T., age 56, 5' 4", weight 140 (not a known diabetic), was admitted Feb. 24, 1947, with diabetic gangrene of the left foot. There was no involvement of the ankle. An ulcer had appeared 4 weeks before admission, on the lateral dorsum of the foot following a sprain.

Conservative treatment was instituted with wet dressings, elevation and chemotherapy. Vascular studies were done. The skin temperatures were done before and after tetraethyl ammonium chloride, paravertebral block and spinal block. The temperature responses following the three procedures were essentially the same. The temperatures before the block on the left extremity at the leg level rose from 87° to 91° following the block. On the basis of this response a left lumbar sympathectomy (2, 3, and 4) was done on March 14, after which the temperature remained elevated as indicated by the previous sympathetic blocks. There was no extension of the gangrene proximal to the foot. Under spinal anesthesia on April 4, the foot was explored and infection was found extending between the metatarsals to the plantar surface. At this time a closed amputation between the junction of the middle and upper thirds of the leg was done inserting a Penrose drain. No tourniquet was used. The drain was removed at the end of 72 hours, the sutures were removed on the 12th postoperative day and the stump healed primarily without infection. Good function with prosthesis is hoped for.

This case exemplifies the desirability of sympathectomy. It insured better healing yet was probably not entirely necessary for safe amputation below the knee.

CONCLUSION

We have presented a review of the amputations done for diabetic gangrene at the John Gaston Hospital during the past 10 years. This study indicates the need of a dependable and simple means for selecting the site of amputation. We feel that much improvement can thus be obtained in regard to mortality, morbidity and as to the site of amputation. Too few cases have been amputated below the knee and too many cases have had surgical procrastination without success, thereby losing the only chance to preserve the knee joint.

Our study of the literature during the past 10 years suggests that this problem has also been neglected elsewhere. Ochsner, de Takáts and others have given a partial answer to the problem, but we feel there is a need for further elaboration.

"Surgical judgment," which is not based on something concrete such as skin temperatures by means of the thermocouple, histamine flare, isotopes, or fluorescein, cannot always be relied upon.

We do not feel the age of the patient should be used in determining the site of amputation on the premise that an individual at some definite stated age will not be able to use a prosthesis.

Sympathectomies are not advised except when the site of amputation can be lowered, or healing can be improved, or when amputation may be avoided. We believe the skin temperatures before and after sympathetic block offer the simplest and most adequate means of studying the problem of amputation.

With the exception of localized gangrene about the digits, there are as a general rule two sites suitable for amputation: namely, the thigh and the junction of the middle and upper thirds of the leg. Adequate evaluation of the patient's circulation will often determine the advisability of extended observation and treatment about the toes and foot. Each patient on admission should be classified as to the possible sites of amputation with or without sympathectomy.

Spinal anesthesia is preferred and surgery is best done without a tourniquet. Refrigeration anesthesia is indicated and often is a life-saving measure in the toxic cases.

We have presented 3 brief case reports. At a later date we hope to have sufficient clinical data to draw more definite conclusions which will indicate that the skin temperature before and after sympathetic block is the most practical and accurate means for selecting the site of amputation.

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THE VALUE OF SPECIAL CLINICS IN TEACHING HOSPITALS

A résumé of the advances in the field of medicine during the last ten or fifteen years will impress one with one outstanding fact; namely, the rapid advances in available specific information, through the application of principles of chemistry, physics, electronics and genetics.

The advances have come so rapidly that it has been almost impossible for the average doctor to keep apace. That this is so, note the great number of graduates, from 1935 to 1943, who, after discharge from the armed services, are endeavoring to return to school for postgraduate study, to take residences in various specialties, or to do refresher work for longer or shorter periods in the clinical fields. Further confirmation of this fact is the decision of the American Specialty Boards to cooperate in offering a Part I Examination in Basic Sciences to be taken by all candidates, regardless of the specialty.

During the 1920 decade vitamins were introduced. Considerable academic interest, but little scientific knowledge, was available on which to base accurate diagnoses of avitaminosis or the use of vitamins in the treatment of patients, this in spite of the blatant, raucous, ridiculous radio commercials. Today, not only is the chem-

ical composition of the most important vitamins known, but they have been synthesized and their specific functions in the various body economics are well known in many cases. This knowledge suggests ever widening applications.

In the late 1930's the sulfa drugs were introduced into the practice of medicine. From the standpoint of saving lives from diseases hardly touched by other methods of treatment, the sulfa drugs added something in the nature of a miracle to our therapeutic armamentarium. In the years since their introduction, chemotherapy has had great extension in many hitherto unrecognized directions.

In World War I, the Committee for the Study of Shock made a tremendous effort to obtain information on the restoration of blood volume. Various solutions, ranging from hypertonic sodium chloride solution through those containing isinglass, gelatin and 6 per cent gum acacia were proposed for use in intravenous medication for the restoration of blood volume. It may be recalled how unsatisfactory all these proposals turned out to be. At about this time Jacques Loeb and his co-workers became interested in the protein molecule and its peculiar chemical and physical properties. No longer was the interest directed toward the amino acid content of protein. There was a sharp distinction between the scientists who considered the protein aggregate in solution as a molecule and those who considered the protein to be only a specialized colloid, obeying the rules and regulations for such particles, as set forth by Graham. No one, in those days, could foresee that when the next World War came, this group of investigators would have solved the problems of maintenance of blood volume and the treatment of shock. Plasma protein, above everything other than the outstanding skills of our well trained surgeons, contributed the very most to the saving of the lives of our young men during the war.

The development of chemotherapeutics has added much to medicine. Penicillin and the numerous antibiotics that have followed have added to the complexity of the picture. No one can hazard an opinion as to where the accumulated mass of research in this new field will lead us in the treatment of human ailments. The synthesis of atabrin and other quinine substitutes, efforts toward the synthetic production of antibiotics, the emphasis which is being placed on the chemistry of the cell nucleus and on nucleoproteins as these pertain to the solution of the cancer problem, the work with the gene and its relationship to the transmission and causation in disturbances associated with the Rh factor, all impress us with the rapidity of progress and the accumulation of new knowledge.

In inorganic chemistry, note the use of radioactive potassium intravenously in the effort to treat leukemia; the isotopes, radioactive and otherwise, including the use of tracer elements, to obtain information pertaining to intermediary metabolism.

In the field of physics, as related to physical medicine and physiologic chemistry, great advances have been made. X-ray diagnosis and treatment have advanced with great strides as the result of the development of more powerful and more accurately controlled equipment. These contributions have been brought to the field of medicine by our scientific friends the physicists. Of special interest is the work of Dr. Conant and his collaborators on the use of radioactive carbon as a tracer element in obtaining new information with respect to carbohydrate metabolism.

With this sketchy résumé of these more or less startling advances, we must also remember that there have been concomitant advances and contributions along the more prosaic lines of medicine and surgery. All of this new knowledge must now be transmitted to medical students by experts on these subjects.

If we accept the thesis that it is our duty to train better practitioners of medicine with greater appreciation and fuller understanding of the recent advances in medicine, based on recent scientific advances in many fields, then it behooves us to look carefully at our methods of medical educational programs.

This is the day of specialism, but real specialism must be based on a broad foundation of general, fundamental knowledge. We must not lose sight of the basic fact that we must first make doctors of medical students before we can make specialists of them, and there lies the danger of specialism in the teaching of undergraduate medical students. In the teaching of postgraduates there is less of this danger, and the value of specialism and specialists is increased.

Teaching hospitals have a fourfold function to perform: the teaching of undergraduate medical students; the teaching of postgraduate physicians (the house staff—interns and residents); the encouragement of its attending staff to self-improvement, technically and culturally, and furnishing the best possible care for its patients which, in the final analysis, is its most important function, the performance of which justifies its existence and public support. It is our considered opinion, based on experience, that special clinics in teaching hospitals (university connected) contribute much to the attainment of these functions.

In the Division of Surgery, at the present time, we have the following special clinics, through which members of the staff rotate,

the term of service for the individual varying from one to two years.

The Thyroid Clinic, established in 1936.

The Cancer Clinic, established in 1938.

The Gastro-intestinal Clinic, established in 1946.

The Pediatric Surgical Clinic, established in 1946.

The Thyroid Clinic, staffed from the Departments of Surgery and Medicine, has, because of a more careful examination of patients visiting the general clinic, revealed the fact that thyroid disease is not a rare condition in this section of the country. For years it was the general opinion among medical men that goiter was a rare disease in this section of the south. Years ago it was an unusual event to have a goiter in a teaching clinic. The explanation then assigned was that "we just don't have goiter here." Since the establishment of our Thyroid Clinic in 1936, 499 cases have been treated surgically. Six deaths have occurred, a mortality rate of 1.2 per cent. The 499 cases were operated upon by 11 surgeons of the staff. In the past 4 years, 1943 to 1946 inclusive, 261 consecutive cases have been operated upon without a death.

The Thyroid Clinic has been the means of disseminating throughout the staff and students those basic principles and criteria of diagnosis, pre- and postoperative care and operative technic so necessary to proper care of this group of seriously ill patients.

The Cancer Clinic, staffed from the Departments of Surgery and Pathology, has resulted in a more profound study of the cancer problem, the dissemination of this knowledge throughout the staff, the establishment of certain criteria of diagnosis and treatment, and a better service to those afflicted ones seeking relief.

The Gastro-intestinal Clinic, staffed from the Departments of Surgery, Medicine, and Radiology, collects, studies and classifies this group and as a result well selected cases are furnished for teaching clinics, better follow-ups are carried on, and more accurate statistics are accumulated.

The Pediatric Surgical Clinic, staffed by the Departments of Surgery and Pediatrics, has proved itself to be of inestimable value both to the general staff and to the special staff and, above both, to the infants and children requiring treatment.

The surgery of children is predicated upon the fundamental facts that infants and children differ from adults in anatomy, physiology, and particularly in their reaction to operative trauma, and that the

necessary adjustments of surgical procedures are not merely matters of scale.

The Clinic emphasizes the necessity of a pediatric attitude of mind on the part of those who carry out surgical procedures upon infants and children. The child is a definite clinical entity and the surgical problems are as definitely dependent upon the peculiar reactions and conditions of that period as are the medical problems. The child, surgically speaking, is not a little man. The adult may be safely treated as a child, but the converse may lead to disaster.

Pediatric surgery, as a specialty, has not at this time received general recognition and, as a result, most of this surgery is done by general surgeons. It may be well that this is so, for there is no substitute for an experience based on a broad, widespread foundation; however, the general surgeon who undertakes to do pediatric surgery will do well to approach its problems by way of pediatric thought and reasoning, rather than by the cerebral pathways of the older surgery.

There is nothing that contributes so much in inspirational value to the esprit de corps as a well directed Special Clinic.

Finally, the patients receive a superservice, characterized by a most careful and searching examination, a more meticulous treatment, and an interested follow-up. They leave the hospital feeling that the humanities have been complied with, they maintain their self respect, and they are grateful.

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*The Sixteenth Annual Postgraduate Surgical Assembly of***THE SOUTHEASTERN SURGICAL CONGRESS**

Hollywood, Florida, April 5, 6, 7, 8, 1948

Attention is called to the Hollywood Assembly of The Southeastern Surgical Congress because:

1. It is held in April whereas heretofore the Assemblies have been held in March, around the 10th. The first week in April should be an ideal time of the year to hold our Assembly in Florida, particularly as far south as Miami. The reasons for the change in dates for the Hollywood Assembly are:

(a) The tourist season is not over until the first week in April and therefore facilities are not available for a convention until after the season. (b) The rates during the tourist season are prohibitive for convention purposes even if facilities were available.

2. It will be noted that we are holding a four day meeting instead of three, as heretofore.

The Hollywood Beach Hotel is ideally located and equipped as a perfect convention hotel and should appeal to northern visitors particularly. We have been promised rates of \$15 per day per person, all inclusive. This includes banquet, floor shows and moving pictures, etc.

According to present indications our attendance is going to be very large. Reservations should be made early. Write the Hotel Management, Hollywood Beach Hotel, Hollywood, Florida.

